

Revision of the genus *Anonconotus* Camerano, 1878 (Orthoptera: Tettigoniidae) with description of *A. pusillus* sp. n. and *A. baracunensis occidentalis* ssp. n.

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Revision of the genus *Anonconotus* Camerano, 1878 (Orthoptera: Tettigoniidae) with description of *A. pusillus* sp. n. and *A. baracunensis occidentalis* ssp. n. - The three species known to date are redescribed. The taxonomic importance of morphological characters is discussed; characters taken one by one are generally difficult to use, but the combination of several characters can be used successfully for identification. No taxonomic change occurs in either *A. alpinus alpinus* (Yersin, 1858) or in *A. a. italo-austriacus* Nadig, 1987. *A. apenninigenus* (Targioni-Tozzetti, 1881) is redescribed; this species is shown to be limited to the Apennine mountains and is not present in the Alps as previously thought. The Alpine populations which were considered as *A. apenninigenus* actually belong to *A. pusillus* sp. n. (populations north of Susa Valley) and to *A. baracunensis occidentalis* ssp. n. (south of Susa Valley). *A. b. baracunensis* Nadig, 1987 is limited to a very small area near the Mon Viso Mountain. A distribution map shows the updated distribution ranges of these allopatric(-parapatric) taxa in the Alps and in the Apennine mountains.

Key-words: Orthoptera - Tettigoniidae - Platycleidini - *Anonconotus* - identification - taxonomy - distribution.

INTRODUCTION

The diagnostic characteristics of the genus *Anonconotus* Camerano, 1878 are the wrinkled upper surface of the pronotum and the relatively short antennae and post-femora. The type species of the genus is *A. alpinus* (Yersin, 1858). The genus is endemic to the Alps and to the Apennine mountains (Harz, 1969). Few studies of this small genus of bush-crickets (Tettigoniidae) have been performed and many past misidentifications make previous references difficult to use. The main references are Griffini (1892), Chopard (1952), Baccetti (1954) and Harz (1969) for general remarks

on the genus, and Dreux (1962) and especially Nadig (1987) for the redescription, distribution and ecology of the different species. The song has been recorded and described by Heller (1988) and Ragge & Reynolds (1998).

Until 1987, the genus included only two described species, *A. alpinus* (Yersin, 1858), described from the Swiss Alps, and *A. apenninigenus* (Targioni-Tozzetti, 1881), described from the Apennine Mountains. For a long time, the distinction between the two species was considered difficult, as the very brief original description of *A. apenninigenus* lacked any kind of diagnostic character and, being based on a single ♀, was of limited value. The characters given by Chopard (1952) were not distinctive either. Both species were even synonymised by La Greca (1985). In 1987, a third species, *A. baracunensis* Nadig, 1987, was described from the Italian Alps.

In 1999, we discovered some populations of *Anonconotus* in the Grées Alps (North-Western Italian Alps) whose morphological characteristics did not match any of the two previously described species. We extended our study area and examined Apennine and other Western-Alpine populations, and soon faced further difficulties in identification. Harz (1969) and mainly Nadig (1987) redescribed *A. apenninigenus* on the basis of Alpine specimens. Actually, as we quickly noticed, topotypical and Alpine populations do not belong to the same species. Moreover, we observed that the Alpine populations of "*A. apenninigenus*" included not one but two different taxa. It therefore appeared very useful to us to redescribe all taxa of this genus and to provide a new identification key.

MATERIAL AND METHODS

We indicate the origin of the studied material in the descriptions of the species and in the Appendix. The collections of Nadig and Harz that we examined are deposited in the Muséum d'histoire naturelle of Geneva (Switzerland) and the collection of La Greca in the Museo Civico di Storia Naturale of Milano (Italy). The *Anonconotus* collected by Yersin are distributed between Geneva (most of the specimens), Lausanne (Musée zoologique) and Zürich (Eidgenössische Technische Hochschule Zürich). Unfortunately there has been no access to the important collection of Dreux (Museum national d'Histoire naturelle of Paris).

Our own specimens were collected mainly between 1998 and 2001, at several localities in the Western Alps, especially in the Hautes-Alpes, Alpes de Haute-Provence (France), Aosta Valley, Piemonte and Apennine (Italy). For the body color analysis, some specimens were photographed. All photos were taken by the authors unless otherwise stated.

Part of the collected and examined material was used for biometrical measurements. Sizes are given in mm. Using a micrometric lens, we measured the length of the postfemur and of the pronotum. Measurements were mainly taken from ♂♂ specimens, which hold most of the taxonomic characters and are of greater help for identification than ♀♀. As the measured specimens were not sampled randomly, we did not carry out statistical tests but rather presented the results in a scatter diagram, which gives a good view of the variability.

The shape of the titillators is a useful character if their tridimensional ultra-structure can be visualized properly. The apical part of the titillator is the toothed part,

the rest is named the basal part. Some pairs of titillators, which were relevant to show intra- and interspecific variability, were micrographed with a SEM in the Muséum d'histoire naturelle of Geneva (see acknowledgements). The titillators of most of our ♂♂ were extracted within a few hours or days of collection. They were quickly cleaned in alcohol to avoid distortion and then displayed on cards which were pinned below the insect.

Preliminary notes on morphology and abbreviations used in the "Description of species and subspecies" section:

coll.	collection
DOBA	dorso-abdominal median band (upper surface of the abdomen, forming a band often limited by the DOLI)
DOLI	dorso-lateral abdominal lines (pale-colored lines running along the abdomen, between the dorsal and lateral parts of the abdomen: see Figs 2e and 2f for examples)
EL	elytra
META	metanotum
Paranota	lateral lobes of the pronotum
PF	postfemora
PR	pronotum
TIT	titillators
T1	first abdominal tergite
T2	second abdominal tergite

RESULTS

TAXONOMICALLY IMPORTANT CHARACTERS

Nadig (1987) rightly emphasized the importance of body size, size and venation of elytra, titillators shape and, to a lesser extent, body color and pattern for identification. The color of the titillators of mature specimens is, for one species (*A. pusillus* sp. n.), a useful character. Coloration of the elytra, as well as pronotum size and shape, are also important characters for us. Harz (1969) and Bellmann & Luquet (1995) use the protruding part of the elytra to separate *A. alpinus* from *A. apenninigenus*. The size of elytra is indeed a very important character, but can also be misleading, as the length of the pronotum and the elytra may vary independently and the elytra may appear more or less protruding depending on the size of the pronotum. We recommend observing the elytra from a lateral or slightly dorsolateral view.

TAXONOMIC DECISIONS

The Alpine populations of "*A. apenninigenus*" are described as *A. pusillus* Carron & Sardet sp. n. and *A. baracunensis occidentalis* Carron & Wermeille ssp. n. *A. baracunensis* Nadig, 1987 is a polytypic species with two subspecies. *A. apenninigenus* (Targioni-Tozzetti, 1881) only exists in the Apennine mountains. The taxonomic status of *A. alpinus alpinus* (Yersin 1858) and *A. alpinus italoaustriacus* Nadig, 1987 remains unchanged. Syntypes are designated for *A. a. alpinus*. *Anonconotus ghiliani* Camerano, 1878 is considered as a synonym of *A. alpinus alpinus* (Yersin, 1858).

IDENTIFICATION KEY TO THE SPECIES AND SUBSPECIES OF THE GENUS *ANONCONOTUS**Male*

- 1 Elytra cream-white with at most a faint buffish or yellowish tinge (which disappears on dry specimens in collections); pronotum elongated at the rear, more than 5 mm in length 2
- Elytra distinctly yellow; pronotum shorter, less than 6 mm 4
- 2 Apex of elytra reaching at least 4/5 of the first abdominal tergite, usually reaching the first 1/5 of the second tergite; apical part of titillators brown, elongated and pointed, with many medium-sized teeth, basal part black and long, flattened, generally widened basally, shape as in Fig. 7-8. 3 (*alpinus*)
- Elytra shorter, not reaching the middle of the first abdominal tergite; apical part of the titillators very elongated, regularly curved, pointed, with many small teeth, basal part brown, not or less flattened, regularly curved in a U-shape, as in Fig. 12a-b *apenninigenus*
- 3 Basal part of the titillators strongly widened in the middle, tapering towards the very narrow tip (according to Nadig, 1987) *alpinus italoaustriacus*
- Basal part of the titillators not or only slightly widened in the middle, of subequal width to the broadly rounded tip *alpinus alpinus*
- 4 Titillators (Fig. 15-16) smaller, with a brown, short, fine, pointed apical part with medium-sized teeth; basal part light brown, thick and not flattened, regularly curved, never twisted; in living specimens stature slender, larva-like, abdomen distinctly narrower, parallel-sided as seen from above; two light buff-whitish dorso-lateral abdominal lines always present, dorso-abdominal median band brown or reddish-brown, rarely brownish olive; pronotum and hind femora shorter (Fig. 3); elytra smaller, deep or, generally, light yellow *pusillus*
- Titillators larger, with a brown, pointed or rounded (with intermediates) apical part with large teeth; basal part usually black or dark brown, flattened and twisted, or simply bent or curved; in living specimens stature plumper, with wider abdomen, more convex-sided as seen from above; light buff dorso-lateral abdominal lines generally absent, dorso-abdominal median band always green except in rare, completely brown ind.; pronotum and hind femora longer (Fig. 3); elytra larger, generally deep yellow (*baracunensis*)
- 5 Apical part of titillators broadly rounded, appearing truncated, basal part generally not twisted (Fig. 12c) *baracunensis baracunensis*
- Apical part of titillators different, pointed or slightly rounded, basal part of variable shape, generally twisted (Fig. 13-14) . . . *baracunensis occidentalis*

Female

- 1 Elytra distinctly cream-white, reaching the hind margin of the metanotum (very rarely only the 2/3), often the first 1/5 of the first abdominal tergite *alpinus*
- Elytra whitish, greyish or yellowish, not reaching the hind margin of the metanotum, color less distinct because of reduced size 2

- 2 Identification possible only of populations, not of single specimens. More than 50 % (usually 99 %) of the ind. of a population with continuous, buffish-white dorso-lateral abdominal lines *pusillus*
- Less than 50 % (usually about 10 %) of the ind. of a population with continuous, buffish-white dorso-lateral abdominal lines 3 (separation of following species difficult)
- 3 Elytra larger, whitish, never yellowish, usually visible; postfemora usually flesh-colored with pinkish or greenish (never yellowish ?) tinge; pronotum on average more elongated *apenninigenus*
- Elytra smaller, greyish, whitish or yellowish, usually not visible; postfemora flesh-colored or light brown often with a yellowish tinge; pronotum on average less elongated *baracunensis*

DESCRIPTION OF THE SPECIES AND SUBSPECIES

1. *Anonconotus alpinus* (Yersin, 1858)*Pterolepis alpina* Yersin, 1858*Analota alpina* (Yersin, 1858) – Brunner von Wattenwyl, 1882*Anonconotus gliliani* Camerano, 1878 **syn. n.**1. 1. *A. alpinus alpinus* (Yersin, 1858)

Type designation: the material collected by Yersin which comprises 28 adults and larvae of *A. alpinus alpinus* had been considered as “unknown” until we discovered it in Geneva, in April 2002. We designated and labelled as syntypes the 10 specimens collected in the locus typicus (explicit individual label). Of the 18 remaining, one was collected in the Jura mountains (Reculet) but there is no indication of the collecting site for the 17 others so we decided as a precaution to expressly exclude them from the type series. In the original description Yersin (1858) explicitly writes “The *Pterolepis* which I used for my description come from the summits of the Alps near Morcles...”.

Syntypes (with original labelling): adult ♂, “*Analota alpina* Yers., 27.IX, Alp Rosse-line”; adult ♀ “Morcles Alpes, a/1666”; adult ♀ “*Pterolepis alpina* Yersin, coll. Yersin, Morcles Alpes, a/1666”; two larvae males and one larva ♀ “*Ptero. alpina* Yers., coll. Yersin, Morcles Alpes, a/1666” (all in the Museum of Geneva). One pair “*Pterolepis alpina* Yers., ♂ and ♀, Alp. Rosseline D^e de Morcles, Yersin” (Zürich). One pair “Morcles, Alpes” (Lausanne).

Type depositories: Muséum d’histoire naturelle of Geneva, Switzerland (6 specimens); Eidgenössische Technische Hochschule Zürich (one pair), Switzerland; Musée zoologique of Lausanne, Switzerland (one pair).

Locus typicus: Switzerland: Alps near Morcles in the canton of Vaud.

Material examined (no. of imagoes of both sexes): 63 in coll. Carron, 3 in coll. Harz, 306 in coll. Nadig and about 200 in coll. La Greca; material from many localities covering the whole distribution range, including the locus typicus (Appendix).

Size: ♂ (n = 78): PF 10.7-14.9; PR 5.3-8.0; ♀ (n = 19): PF 12.5-14.8 (15.3 in Harz, 1969), PR 6.3-7.1 (7.8 in Harz, 1969). See Fig. 3. ♂ with largest PR/PF are from lowland localities of the southern part of the range: Col de Perty, 1100-1300 m, Mont Ventoux. 1450-1650 m, Col de Maure, 1346 m. Smallest ♂ mostly from the Alps of the canton of Vaud, at the type locality.

PR shape: variable but longer, posteriorly more elongated and wider than in other species (Fig. 3, 4d, 5d).

Elytra: ♂: shape and venation in Nadig (1987) and Heller (1988). EL (Fig. 4d and 6d) reaching 4/5 of T1 to 1/3 of T2. EL cream-white with, especially in northern populations, a light yellowish tinge which disappears on dry specimens. Venation less

reduced than in other species. ♀: EL (Fig. 5d) usually reaching 1/5 to 1/3 of T1, always visible in living specimens, rarely completely hidden under the PR in some dry specimens; EL color as in ♂♂.

Titillators: variation in shape and size given in Fig. 7-8. Apical part light or dark brown, straight, typically fine and elongated, with small and medium-sized teeth; basal part deep shining black, flattened, more or less elongated and widened in the middle, never twisted.

Body color and pattern: variable species, with background color varying from dark brown to light green (Fig. 1a-d). DOLI not continuous, mostly formed by series of black and buffish spots, rarely forming uninterrupted buff-whitish lines. Ventral part of paranota whitish, rather dull, usually lacking the bright yellowish or mint-green tinges of *pusillus* sp. n. and *baracunensis* - if present, usually limited to the anterior part of the paranota, behind the head. PF (♂, ♀) flesh-colored with pinkish tinge, generally without yellowish tinge. See also Nadig, 1987. The beautiful original painting by Alexandre Yersin himself, published in the *Annales de la Société Entomologique de France* in 1858, is reproduced here (Fig. 6e-f) with the kind permission of the *Rédaction des Annales de la Société Entomologique de France*.

Song: succession of echemes each lasting 1.5 to 2.5 (1-3) seconds (Heller, 1988; Ragge & Reynolds, 1998).

Distribution: see Fig. 17 and Appendix. External side of the alpine Arc, from the Département of Alpes Maritimes (col de la Cayolle) and Vaucluse (Mont Ventoux) to the Swiss Western Prealps and Alps. There is an erroneous reference by Chopard (1952) in Saint-Martin Vésubie which refers to *A. baracunensis occidentalis* ssp. n. In the Western Alps, *A. a. alpinus* enters Italy only in Susa Valley, Col of the Petit-Saint-Bernard and eastwards through the northern side of the Aosta Valley as far as the Biella region. Also a few data exist from the Eastern Alps, in Austria (Arlberg, N-Tirol) and Italy (S-Tirol) (synthesis in Nadig, 1987); more research is needed in this region.

1. 2. *A. alpinus italoaustriacus* Nadig, 1987

Holotype ♂ (examined). Well preserved, dry specimen with titillators mounted on card. Collected by Nadig on 3. IX. 1982.

Locus typicus: border Austria / Italy: Southern Tirol, Pustertal: Strickberg above Innichen, 2050-2150 m.

Type depository: Muséum d'histoire naturelle of Geneva, Switzerland.

Other material examined: paratypes (4 ♂, 2 ♀) in coll. Nadig.

Titillators: basal part of the TIT strongly widened in the middle, tapering towards the very narrow tip (see drawing in Nadig, 1987). The shape of the TIT is the only character separating this ssp. from the nominotypical ssp.

Distribution: E-Tirol (Austria) and S-Tirol (Italia / Austria) (Fig. 17).

FIG. 1

Left: *A. alpinus*. Topotypical ♂ (a) and ♀ (c), Switzerland, Portail de Fully, September 1999; ♂ (b) ♀ (d), France, Col d'Allos, August 2001. Right: *A. apenninigenus*: ♂ (e - f) and ♀ (g - h), Italy, Monti Sibillini, Val Bolognola. September 2001. Note whitish elytra of both sexes. (Photos f and h by Bertrand Baur).



2. *Anonconotus apenninigenus* (Targioni-Tozzetti, 1881)

Omalota apenninigena Targioni-Tozzetti, 1881

Analota apenninigena (T.-Tozzetti, 1881) – Brunner von Wattenwyl, 1882

Anonconotus alpinus; La Greca 1985 (partim) (nec Yersin, 1858) – misidentification

Holotype ♀ (examined). Specimen in alcohol, dissected in the middle of the abdomen, shape also altered by long conservation in alcohol (Fig. 10). Original label (Fig. 9): “*Omalota apenninigena*. M. 484. Coll. [361. ? unreadable]. 1866. St. Ilario. R. Museo di Fis. e St. Nat. Di Firenze”. Along with the original label, two other, recently created (by whom?) labels: “0546 Holotypus ♀” and “La Specola - Firenze, *Omalota apenninigena* n. sp. Targ. Tozz. 1881, Olotipo e allotipo, S. Ilario (Fi)”.

Type depository: Museo zoologica “La Specola” of Firenze, Italy.

Locus typicus: Italy: Apennine mountains, precise locality unidentified (indications from Targioni-Tozzetti doubtful).

Other material examined (no. of imago of both sexes): 3 in coll. Carron and 24 in coll. Nadig, all from Italy Monti Sibillini, Val Bolognola; 2 in coll. La Greca, from Italy Monti Reatini, Jaccio Crudele.

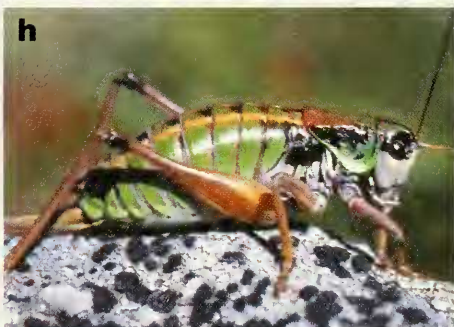
We assume that Targioni-Tozzetti collected only two specimens as there is no other specimen in the entire Firenze museum material with the exception of a pair of *A. pusillus* sp. n. collected by “Isp. For. Di Torino in Torino” in 1879. Targioni-Tozzetti did not designate any types in his description of the species, or on the label joined to his material. As his description clearly refers to a single ♀ specimen (one value for each measurement given, no indication on variability), there is no reason to think that this is not the holotype. Along with the holotype, a subadult male is labelled as “allotype” (Fig. 11).

The precise locus typicus should be considered as doubtful. The only indication in the original description is “In subapenninis prope Florentiam reperta” (found in the lower Apennine near Firenze). In our research we could not find any Santo Ilario (or Sant’Ilario) above 800 m a.s.l. in the whole Tuscany region, nor any locality bearing this name situated close to a mountain where the species could live. Later, Targioni-Tozzetti (1898) mentioned *Analota apenninigena* from Roccaforte (Firenze). Baccetti (1954) found that these specimens, identified by T.-Tozzetti and labelled *Anatola apenninigena* were *Pholidoptera*. Moreover, in spite of our thorough research, no Roccaforte was to be found in the Tuscany region. Furthermore, a new label has recently been placed with these *Pholidoptera*, indicating that they were collected in 1878 by Cavanna in “Roccaforte RC = Reggio Calabria”, thus in the extreme south of Italy.

Interestingly, in a report of a meeting of the Italian Entomological Society, Cavanna (1881) wrote these words: “Il Presidente prof. Targioni Tozzetti descrive le seguenti specie nuove di Ortoteri italiani: 1 *Ectobia*..., 6 *Thamnotrizon Brunneri* della Majelletta in Abruzzo, 7 *Omalota apenninigena* della Consuma, 8 *Pezotettix brutius* del Monte Morrone in Abruzzo...” The mention of “Consuma” does not correspond

FIG. 2

Left: *A. baracunensis occidentalis* ssp. n.; a-b = ♂, d = ♀, Italy, colle dell’Assietta, August 1998. Note plump outline and green upper-side of abdomen of ♂♂; c = ♂ with rare grey-brownish coloration on whole body, France, col de Montgenèvre, August 2000. Right: *A. pusillus* sp. n.: e-f = ♂, h = ♀, Italy, Aosta Valley, Lillaz, August 1999. Note slender outline and striped pattern of ♂♂; g = ♂ with unusual brownish olive upper-side of abdomen, Italy, Canavese, Santa Elisabetta, August 2000.



with the locality given 15 years before by T.-Tozzetti, and it is difficult to understand the origin of this record. It certainly refers to the Passo del Consuma, 27 km west of Firenze, situated at an elevation of 1060 m, where the collecting site might have been. Nevertheless, there is still some reason to doubt. In September 2001, we visited all the higher meadows in the Pratomagno Chain and the Monte Falterone, very close to Consuma, and, although we might have missed the species, we found neither *Anonconotus* nor suitable habitats. Potentially suitable sites were found in the pastures of Monte-Secchieta – Poggio Uomo di Sasso and on the Monte Falco, where some alpine relicts like the flower *Gentiana verna* can be found. Secondly, we can not exclude an error in the labeling of the material. As Cavanna reports, T.-Tozzetti described in the same period species from Monte Morrone and Majelletta. These mountains are situated close to the Maiella region which is situated 280 km south of Firenze and where alpine habitats are known to exist. Moreover, there is a locality named Sant'Ilario (Sangro) in this exact region! However, Baccetti (1959) studied the Orthoptera of the Maiella and did not find *Anonconotus* so the question is still open.

To our knowledge, no *Anonconotus* specimen except those of T.-Tozzetti has been collected in the Tuscany by any orthopterist. The locality closest to Firenze, where *A. apenninigenus* can presently be found is the Monti Sibillini (Marche region), where it was first discovered by Galvagni (1959) and where Nadig (and we) collected some specimens. In conclusion, we consider the locus typicus as the "Apennine mountains", with the precise locality unidentified.

Size: ♂ (n = 15): PF 11.3-12.5; PR 5.3-5.9; ♀ (n = 14): PF 12.4-14.3; PR 5.9-6.7. Holotype (♀): PF 13.4; PR 5.2 abnormally wrinkled (Fig. 10) and contracted, probably by conservation in alcohol. These values give an incomplete aspect of the variability because of few specimens measured, but values tend to be intermediate between *alpinus* and *baracmunensis* (Fig. 3).

PR shape: intermediate between *alpinus* and *baracmunensis*, moderately elongated (Fig. 3, 4c, 5c).

Elytra: ♂ (Fig. 4c and 6c): a little shorter than in *A. alpinus*, apical part and anal field reduced. In lateral view, apex reaching 9/10 of the META to 1/4 of T1. EL cream-white or white with a light buffish tinge, without yellowish tinge; apical, colored part reduced. In dorsal view, only apical part of EL protruding from under the PR. ♀: EL (Fig. 5c) reaching 1/3 to 2/3 of the META, thus usually clearly visible in living specimens; EL whitish or grey whitish, never yellowish. Holotype: EL reaching about 1/4 of the META, protruding from under the PR.

TIT: we could see only 6 pairs of TIT in specimens from the Monti Sibillini (Val Bolognola) and one pair in a ♂ from another Mountain Massif, the Monti Reatini, 50 km S-W of the Monti Sibillini. The three-dimensional structure and the shape are clearly different from those in other species (Fig. 12a-b). All brown in color; apical part typically very elongated, curved, pointed with many small teeth; basal part only slightly flattened, regularly curved in a U-shape, twisted or not.

Body color and pattern: ♂ dark brown with reddish tinge (Fig. 1e-f), ♀ green (Fig. 1g-h) or completely brown; DOLI buff-whitish, not continuous. PF (♂, ♀) flesh-colored with greenish or pinkish tinge.

Song: around mid-day on 9. X. 2001, after 4 weeks of silent captivity in Carron's office, a ♂ suddenly produced three echemes of about 3 (beginning missed), then 6 and 8 seconds, respectively. The observer could directly watch the ♂ sing and observe the movements of the EL. During the song the PR was raised to give space to the moving EL, and the subgenital plate was strongly lowered and the usually hidden soft parts of the abdomen's apex were somewhat protruded. The song could be heard from a distance of 40 cm only. These three echemes were the only ones that we heard, in spite of long observations afterwards. The echemes are distinctly longer than in *A. alpinus* (1.5-2.5 seconds: Heller, 1988). It seems that the factor inducing the song was the exposure to bright sun light. These are the first observations ever reported on the song activity of this species.

Distribution: Fig. 17; Apennine: verified data only from Monti Sibillini (Marche region) and Monti Reatini (Lazio region).

3. *Anonconotus baracunensis* Nadig, 1987

3. 1. *Anonconotus baracunensis baracunensis* Nadig, 1987

Holotype ♂ (examined). Well preserved, dry specimen with titillators mounted on card. Collected by Nadig on 30. VIII. 1985.

Type depository: Muséum d'histoire naturelle of Geneva, Switzerland.

Locus typicus: Italy: Piemonte: V. Carbonieri, under Cle. Baracun, 2020 m.

Other material examined (no. of imagoes of both sexes): paratypes (7 ♂, 4 ♀), 70 from locus typicus; from France, Queyras, Belvédère du Viso; from Italy, Val del Po, Pian del Re, all in coll. Nadig; 16 in coll. Carron from France. Queyras, Belvédère du Viso and from Italy, Val del Po, Pian del Re; 2 in coll. La Greca from Italy, Val del Po, Pian Melzé and Rocce Losere.

Size: ♂ (n = 34): PF 10.0-13.1 (holotype: 13.5*); PR 4.2-5.3 (holotype: 5.0*); ♀ (n = 5): PF 13.2-14.1; PR 5.3-5.7. Values give an incomplete aspect of the variability because of few measured specimens. See Fig. 3. [* = values given by Nadig (1987).]

TIT: (Fig. 12c). Brown or dark brown, not (never ?) black; apical part typically broadly rounded and bent outwards, appearing truncated, with a variable number of large teeth, sometimes also with small teeth between the large ones; basal part variably flattened and widened in the middle, generally not twisted but simply bent.

Song: no spontaneous song was recorded by Heller (1988).

Other characters: see *A. b. occidentalis*.

Distribution: Fig. 17 and Appendix; distribution area limited to a very small region north of the Mon Viso Mountain.

3. 2. *Anonconotus baracunensis occidentalis* Carron & Wermeille ssp. n.

Anonconotus apenninigenus; Chopard 1952, Harz 1969, Nadig 1987 (partim) (nec Targioni-Tozzetti, 1881) - misidentifications

Anonconotus alpinus; La Greca 1985 (partim) (nec Yersin, 1858) - misidentification

Holotype ♂. France: Hautes-Alpes, Col d'Izoard, 10. IX. 2000, leg G. Carron. Dry specimen with titillators mounted on card.

Type depository: Muséum d'histoire naturelle of Geneva, Switzerland.

Locus typicus: France: Hautes-Alpes, col d'Izoard (north-exposed side, near Refuge Napoléon), 2300-2400 m.

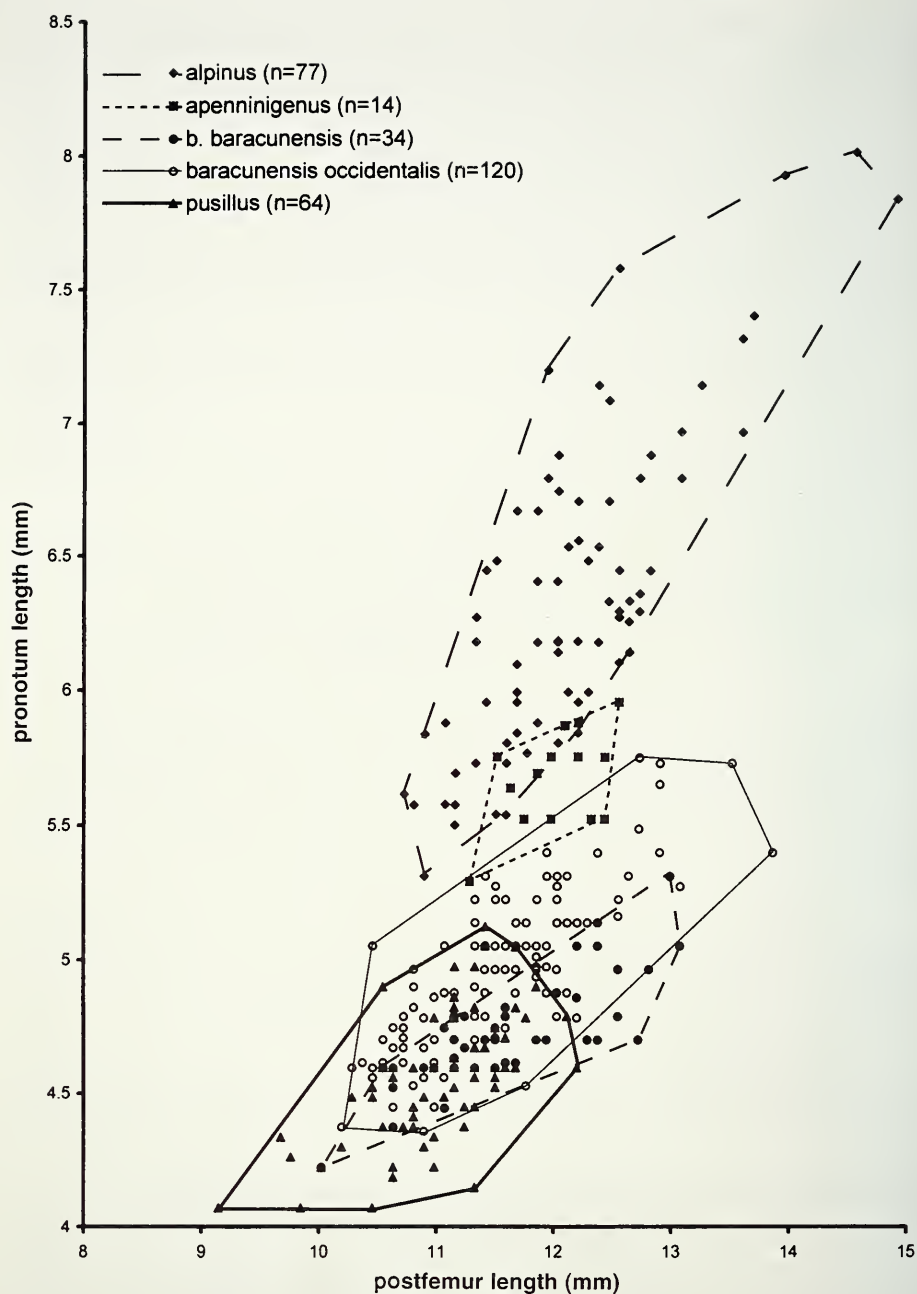


FIG. 3

Scatter diagram of postfemur (x) and pronotum (y) lengths. Scale of Y-axis expanded. "Convex polygons" drawn by joining "extreme" values. Large variability in all species; less interspecific overlap on pronotum than on postfemur length.

Paratypes from the locus typicus (8 ♂, 1 ♀, same date), and from France: Col de Montgenèvre, north-exposed slopes south of the col (5 ♂, 1 ♀ 9. IX. 2000); in Mus. Geneva.

Other material examined (no. of imagoes of both sexes): 27 in coll. Carron, 2 in coll. Harz, 403 in coll. Nadig and about 250 in coll. La Greca; material from many localities covering the whole distribution range (Appendix).

Derivatio nominis: *occidentalis* = “western”; the species name refers to the distribution area of the taxon, which is endemic to the Western Alps. This geographically “broad” term has been chosen to indicate that it is much more widespread than the nominotypical ssp.

Differential diagnosis

♂ easily distinguishable from those of *A. alpinus* and *A. apenninigenus* by the yellow (instead of whitish) EL and shorter pronotum, and from *A. pusillus* by the larger, plumper body structure, green DOBA and absence of DOLI. It can also be separated from all other taxa by the color, size and shape of the TIT, although differences are sometimes rather indistinct.

♀: very similar to those of other species, with the exception of *A. alpinus*, which has much larger EL; isolated specimens impossible to identify with certainty. *A. pusillus* ♀ have continuous DOLI. Populations with less than 20 % of the ♀ with continuous DOLI undoubtedly belong to *A. baracunensis* or *A. apenninigenus*. *A. apenninigenus* has larger EL, a slightly more elongated PR (averages = 6.2 vs. 5.4), and lacks a yellowish tinge on PF (often present in *A. baracunensis*).

Description of the holotype

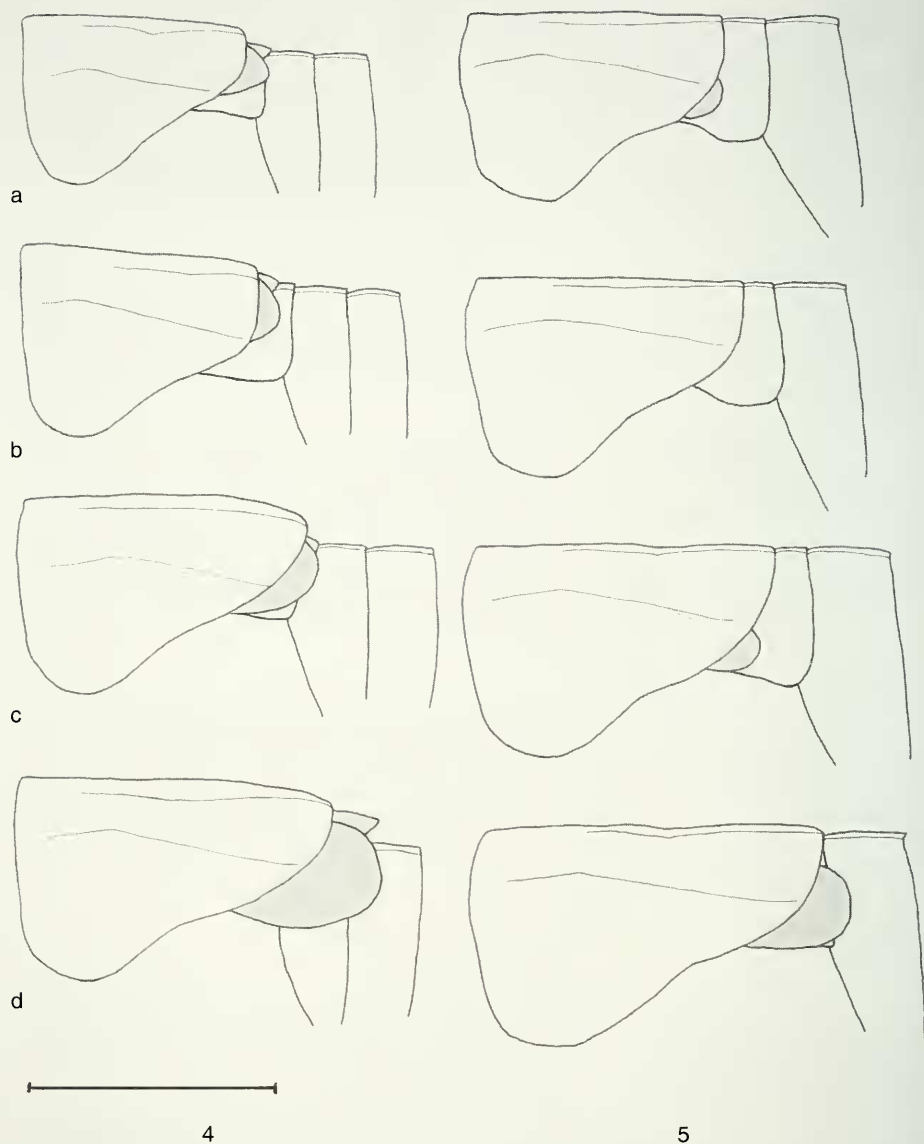
Size: PF 11.0; PR 5.0. EL: left reaching 4.5/5, right EL reaching 4/5 of the META, both clearly protruding from under the pronotum. DOBA green, DOLI buff-whitish, visible only on the first abdominal tergites. PR: paranota black, only ventrally whitish. TIT: apical part brown, conical, with blunt apex, with 5 teeth on each TIT; basal part brown-black, forming an angle with the apical part, flattened, widened basally, medially bent-twisted, becoming more slender distally.

Variation

Size: ♂ (n = 121): PF 10.2-13.9; PR 4.4-5.7; ♀ (n = 21): PF 11.8-14.1; PR 4.6-5.5 (values for ♀ give an incomplete aspect of the variability because of few measured specimens). Important intraspecific variation of PF/PR lengths within and between localities. Largest PF found in the south-eastern part of the range (Italy: Valle dell'Arma, 1300-1600 m) and shortest in the north-western part (France: Col d'Izoard, 2400 m). This suggests a latitudinal gradient, but altitude also has a strong influence on size (shortening with increasing altitude). See Fig. 3.

PR shape: variable, not elongated at the rear (Fig. 3, 4 b, 5 b).

EL: in ♂ (Fig. 4b, 6b) reaching 3/4 of the META to 1/4 of the T1; smaller than in *A. apenninigenus*, with apical part more reduced and venation even more indistinct. See also the drawing by Nadig (1987), which was given for the Alpine “*apenninigenus*” and actually refers to *b. occidentalis*. EL generally deep, bright yellow, with a waxy appearance. ♀ (Fig. 5b): EL reaching usually 1/5 to 1/4 of the META, usually completely hidden under the PR; whitish, yellowish or grey.



FIGS 4-5

Pronotum, metanotum, elytra (shaded) and first abdominal tergites of ♂ (Fig. 4) and ♀ (Fig. 5) *Anonconotus* spp.; lateral, slightly from above view; a = *A. pusillus* sp. n., b = *A. baracunensis*, c = *A. apenninigenus*, d = *A. alpinus*. Scale = 5 mm. These figures show "average" morphology, species are difficult to separate on the basis of only these characters (see text for variability).

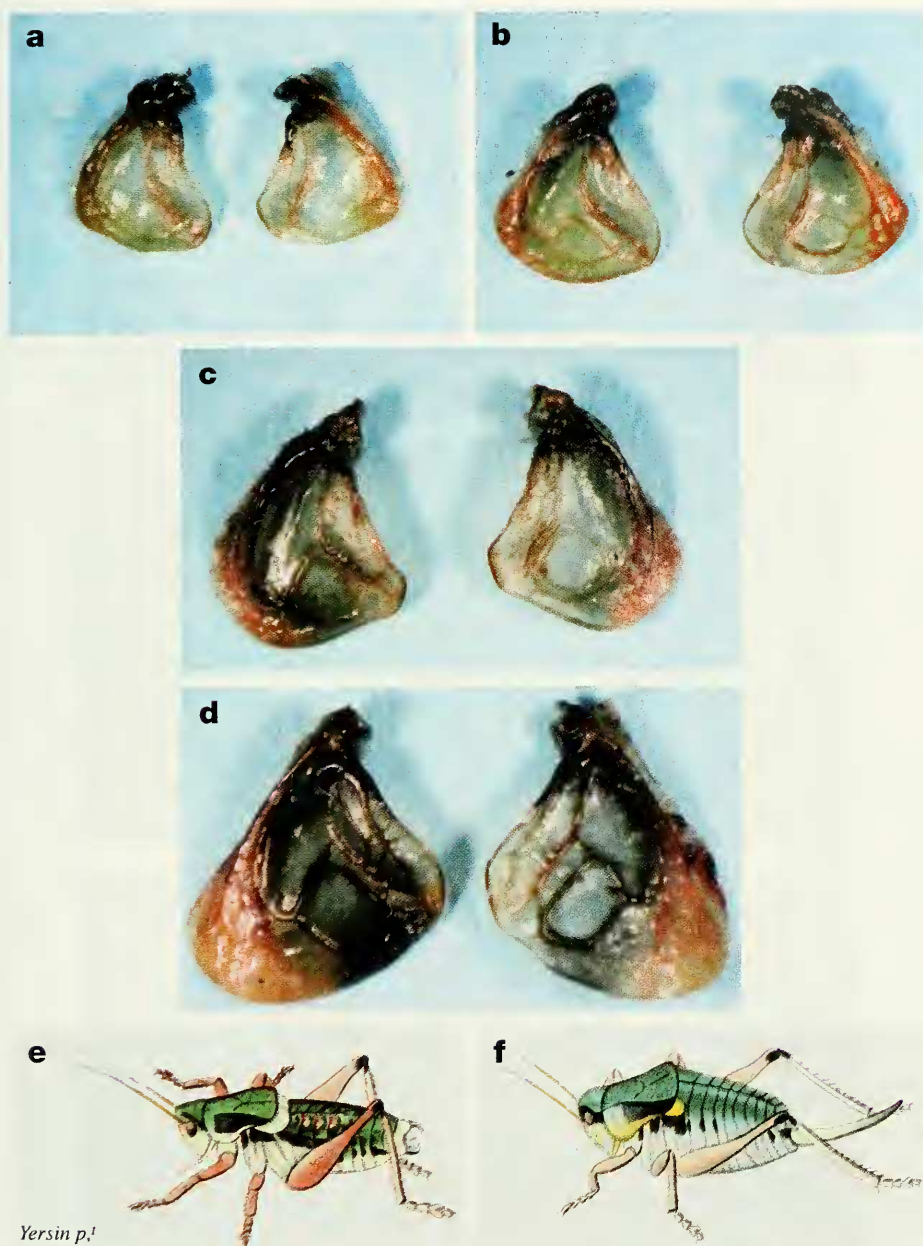


FIG. 6

a-d: Elytra of ♂ *Anonconotus* spp., a = *A. pusillus* sp. n., b = *A. baracunensis*, c = *A. apenninigenus*, d = *A. alpinus*; e-f: ♂ and ♀ of *A. alpinus alpinus* painted by Yersin (1858) himself.

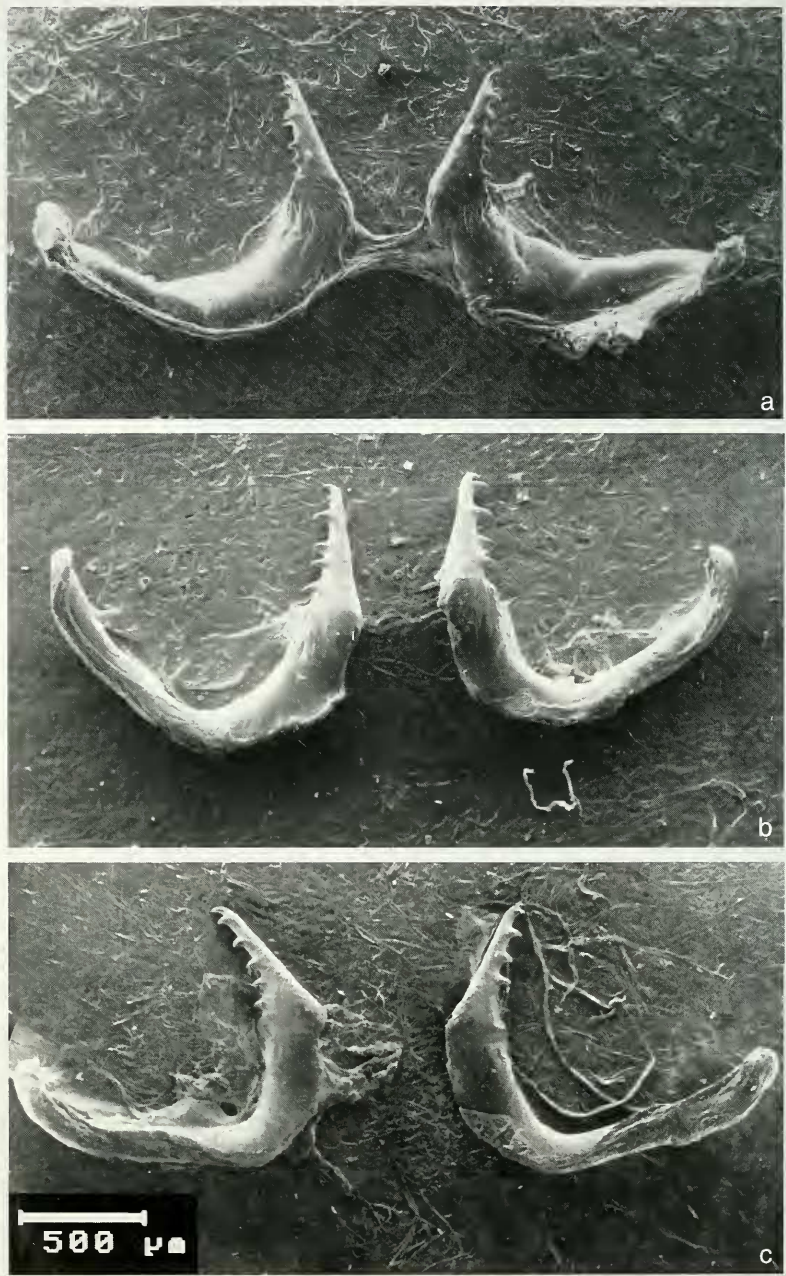


FIG. 7

Titillators of *A. alpinus*: a = Italy, Aosta Valley, Gressoney; b-c France, Col d'Allos.

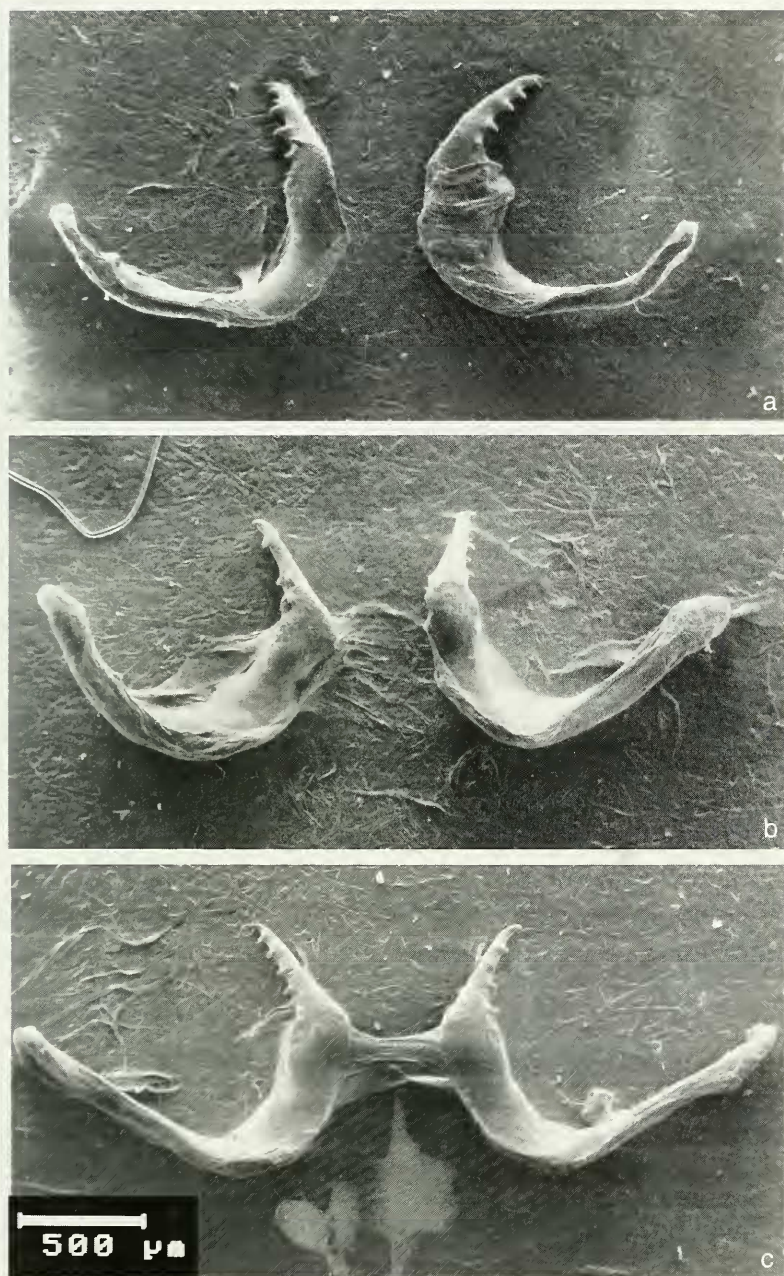


FIG. 8

Titillators of *A. alpinus*; a = France, Col d'Allos; b = F, Col du Galibier; c = F, chaîne du Jura, Reculet.

TIT: variation in shape and size given in Fig. 13-14; apical part light brown or brown, conical, more or less elongated and pointed, widening a little (Fig. 13a-c), or strongly (Fig. 14c-d) towards the base, apex usually with a small, curved tooth but sometimes with the apex more broadly rounded (Fig. 14a-b) and somewhat similar to the nominotypical ssp.; teeth large; basal part dark brown or of a deep shining black, flattened, variably widened basally or medially, generally with two angles: one at the base of the apical part, and a second inflexion / torsion in the middle, giving a typical twisted upside-down shape (Fig. 13a-b). Populations from the Maritime Alps (F, I) have smaller, stouter, less twisted TIT, sometimes similar to those of *A. alpinus* (compare Fig. 13c with Fig. 7b).

Body color and pattern: ♂: green often with a yellowish tinge, more or less darkened with black laterally, abdomen dorsally shining light green in 98 % of ind. (Fig. 2a-b); rarely body color light brown (Fig. 2c); never green with brown reddish DOBA; DOLI generally indistinct or limited to the first 4 tergites, very rarely continuous, if so greenish rather than buffish. ♀ (Fig. 2d) very variable, green or olive to light brown with buff or reddish tinges, also mottled with brown and green; DOLI buff-whitish or greenish, continuous in about 5-15 % of ind. PF (♂, ♀) flesh-colored or light brown with a yellowish or pinkish tinge, generally whitish interno-inferiorly.

Song

A few echemes of only 1-2 seconds were recorded in the laboratory by Heller (1988), no song was heard in nature.

Distribution

Fig. 17 and Appendix; Italian and French South-Western Alps, south of the Durance (F) and the Susa (I) Valleys; most western known locality: Col de la Bonette (a pair in coll. Harz). The mention of Col d'Allos by Azam (1901) was an error: we checked this population and found that it belongs to *alpinus*.

4. *Anonconotus pusillus* Carron & Sardet sp. n.

Anonconotus apenninigenus (Targioni-Tozzetti) (partim) - Nadig, 1987; nec *Anonconotus apenninigenus* (Targioni-Tozzetti, 1881)

Holotype ♂. Italie: Val d'Aoste, Val Champorcher, Chardonney, 12. IX. 1999 leg G. Carron. Dry specimen with titillators mounted on card.

Type depository: Muséum d'histoire naturelle of Geneva, Switzerland.

Locus typicus: Italy: Aosta Valley, Champorcher Valley, Chardonney, Laris, 2000-2300 m.

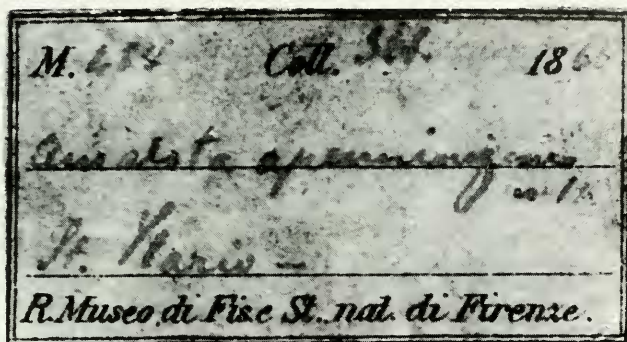
Paratypes from the locus typicus (3 ♂, 4 ♀, same date) and also from Piemonte, Colle della Colombardo, N-side (5 ♂, 2 ♀, 8. IX. 2000), Sant'Elisabetta in Canavese (2 ♂, 2 ♀, 7. IX. 2000), Piamprato in Val Soana (2 ♀, 8. IX. 2000) (all in Italy); in Mus. Geneva.

Other material examined (no. of imagoes of both sexes): 82 in coll. Carron, 116 in coll. Nadig and about 10 in coll. La Greca; material from several localities covering the whole distribution range (Appendix).

Derivatio nominis: *pusillus* = "small, incompletely grown"; the species name refers to the small, larva-like body of the ♂.

Differential diagnosis

♂ easily distinguished from other taxa with yellow-EL by the small, slender, larva-like stature, by the brown and striped upper-side of the abdomen (light green in *A. baracunensis*), and by the very diagnostic small, brown TIT (which resemble very small *A. alpinus* TIT).



FIGS 9-11

9. Original label of *Omalota apenninigena*, written by Targioni-Tozzetti. 10. Holotype of *Anonconotus apenninigenus* (in alcohol). 11. Larva of *Anonconotus* (in alcohol), designated as "allotype" of *A. apenninigenus*.

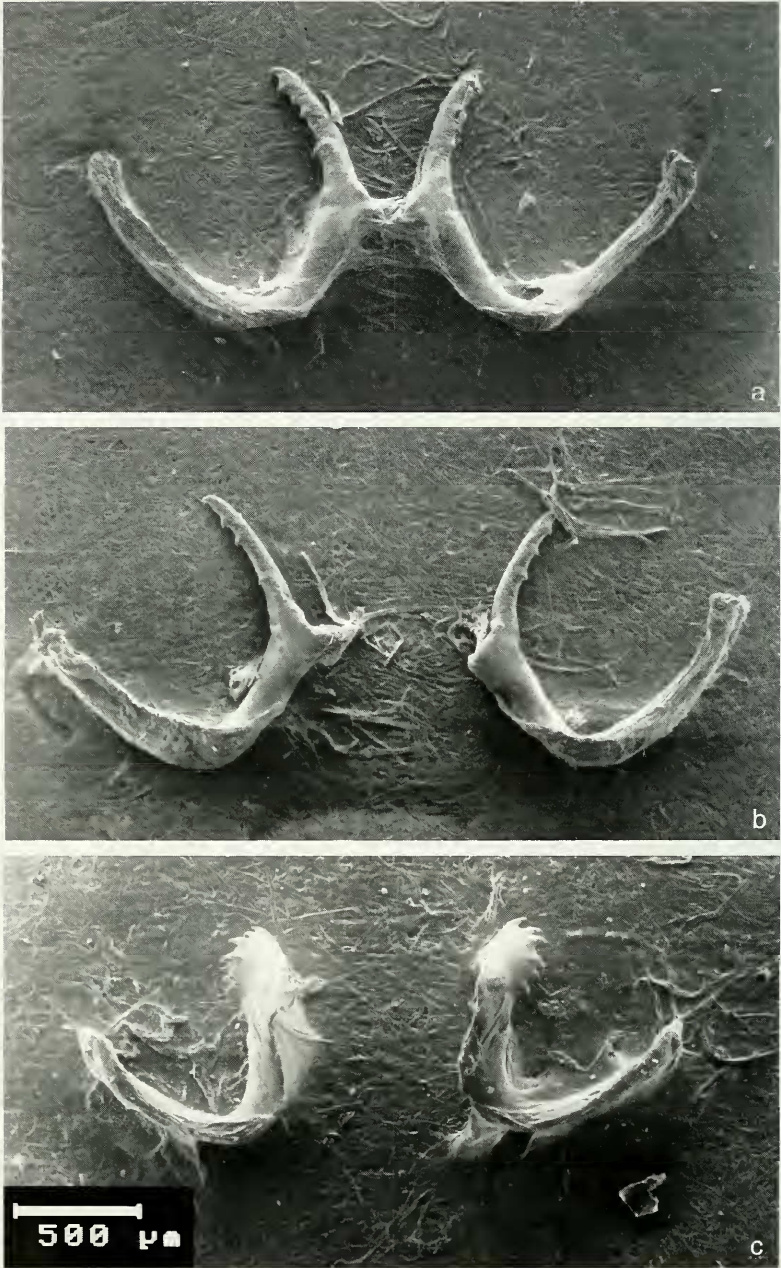


FIG. 12

Titillators of *A. apenninigenus* (a-b) and *A. b. baracunensis* (c); a-b: Italy, Monti Sibillini (Apennine), Val Bolognola, note long, curved, finely toothed apical part; c = I, Alto vallo del Po, Pian del Ré, note widened apical part.

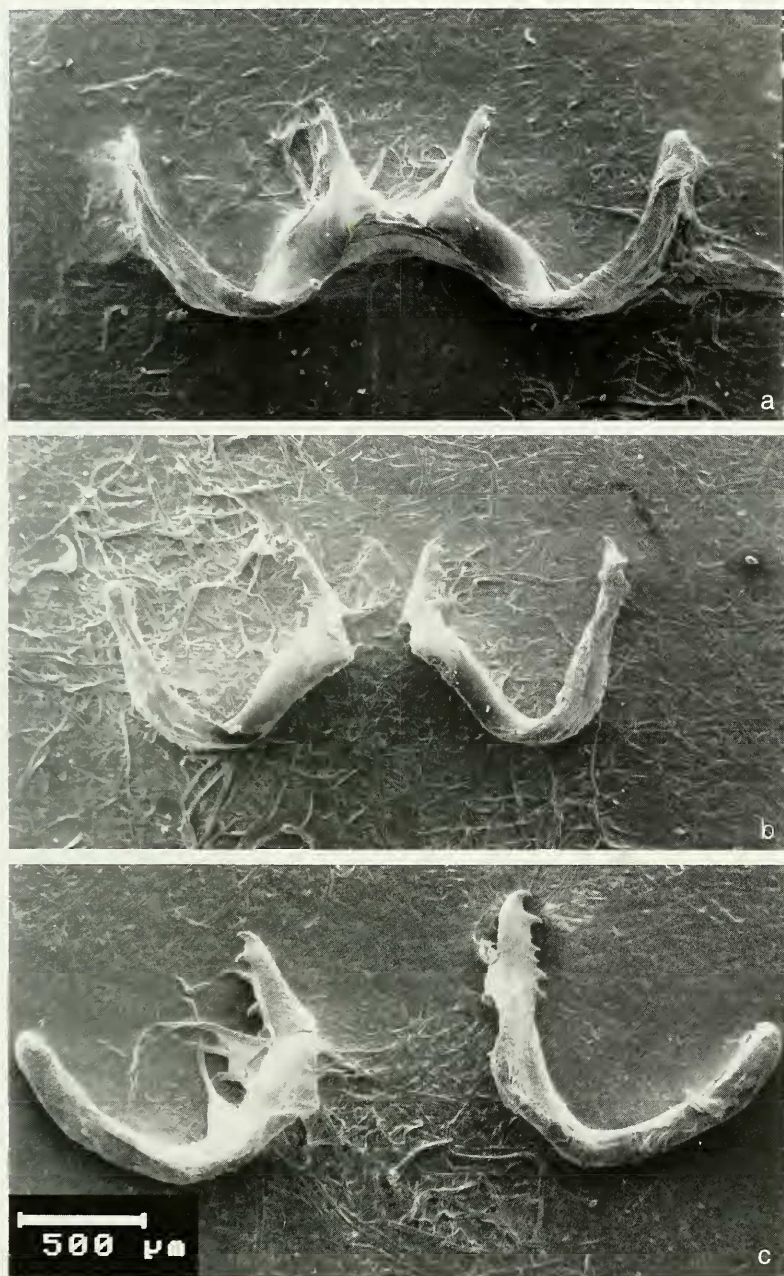


FIG. 13

Variation in shape of titillators of *A. baracunensis occidentalis* ssp. n.; a = France, Col de Montgenèvre; b = F, Col d'Izoard (locus typicus); c = F, Alpes maritimes, Mercantour, atypical shape similar to that of *A. alpinus* (compare with Fig. 7b) but larger teeth distinctive.

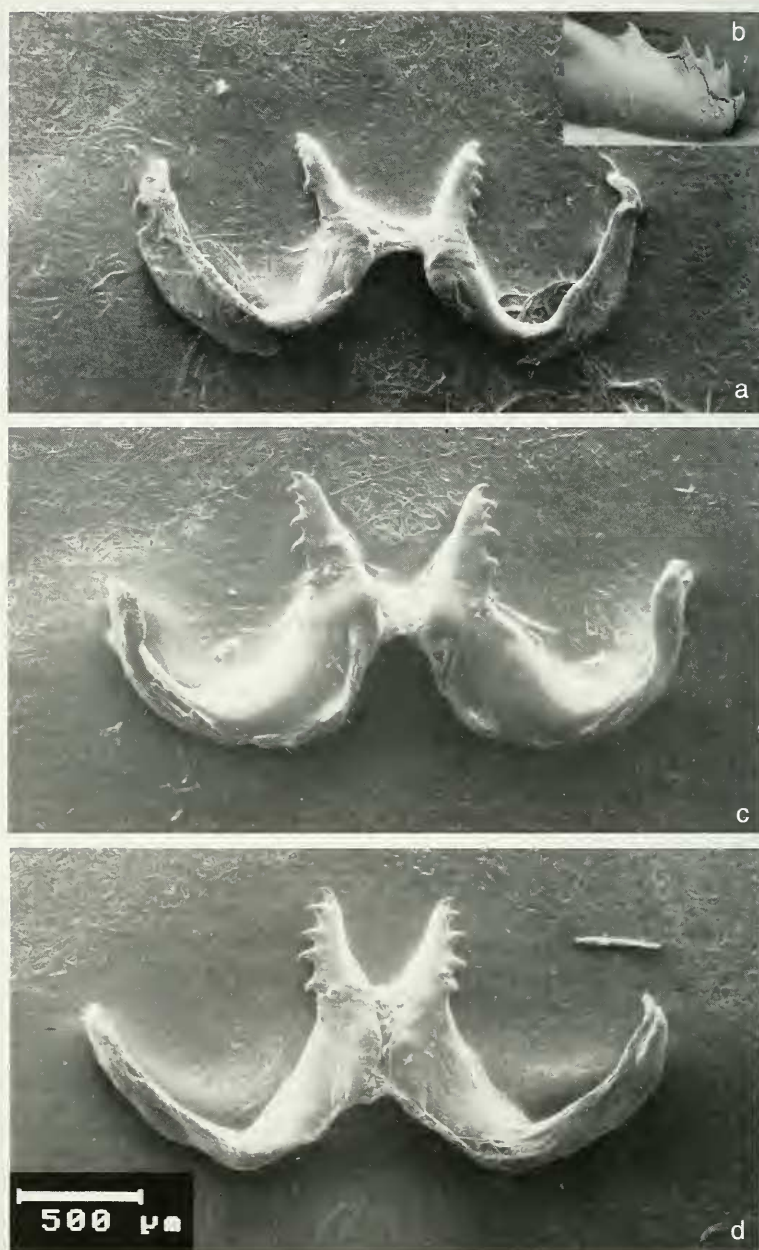


FIG. 14

Variation in shape of titillators of *A. baracuniensis occidentalis* ssp. n.: a = Italy, Piemonte, val Chisone, Fenestrelle, note small size; b = enlargement to show atypical, not pointed apical part; c = I. Piemonte (Cuneo), Frabosa, Prato Nevoso; d = I. Piemonte (Cuneo), Monesi – Colle Rossa; c and d from the Italian Maritime Alps, showing a particular, smaller, stouter shape than in other populations.

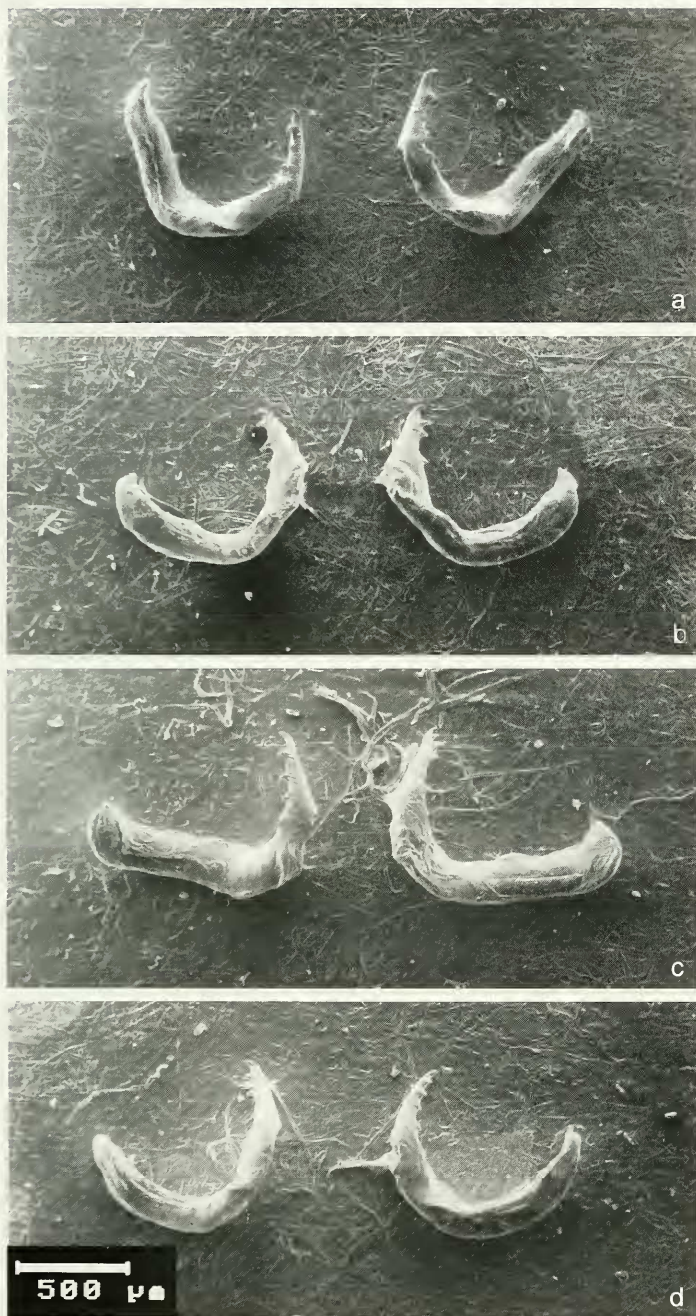


FIG. 15

Variation in shape of titillators of *A. pusillus* ssp. n.; a-d = Italy, Piemonte, Canavese, Santa Elisabetta. Note small size and thick basal part.

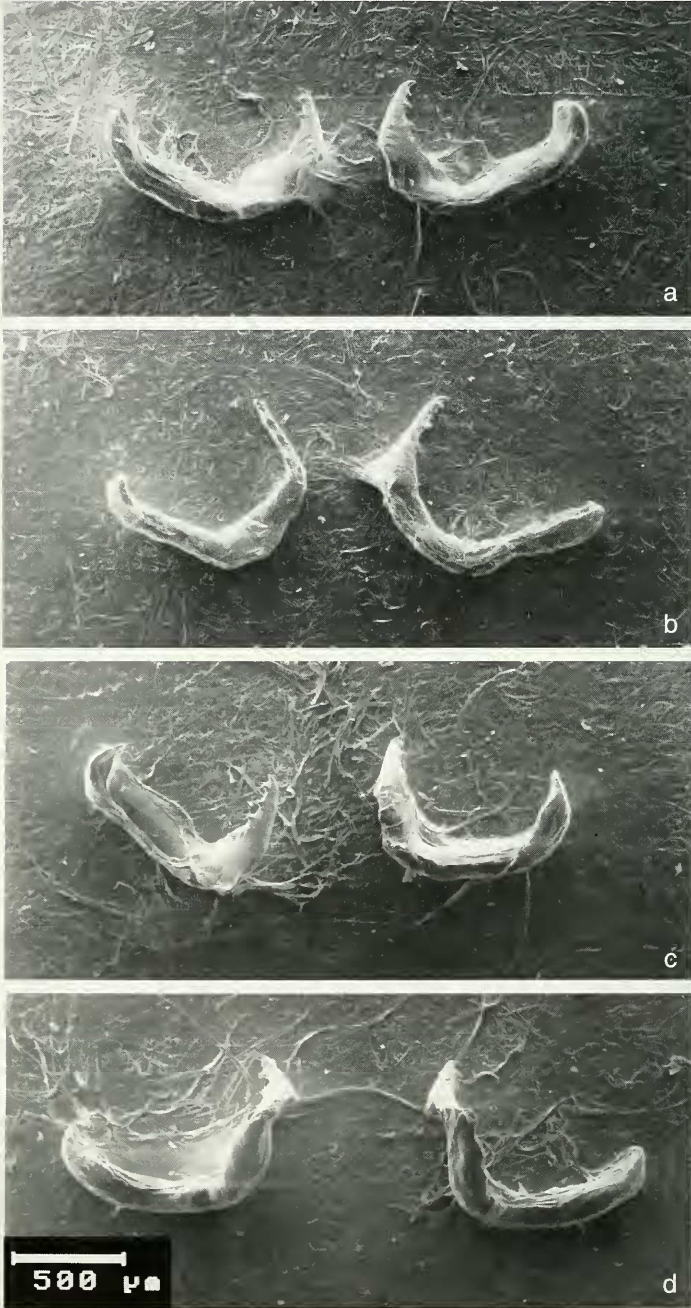


FIG. 16

Variation in shape of titillators of *A. pusillus* ssp. n.: a, c, d = Italy, Piemonte, Canavese, Santa Elisabetta; b = I, Piemonte, Canavese, Piamprato, note shape similar to that of a small *A. alpinus* (compare with Fig. 7c).

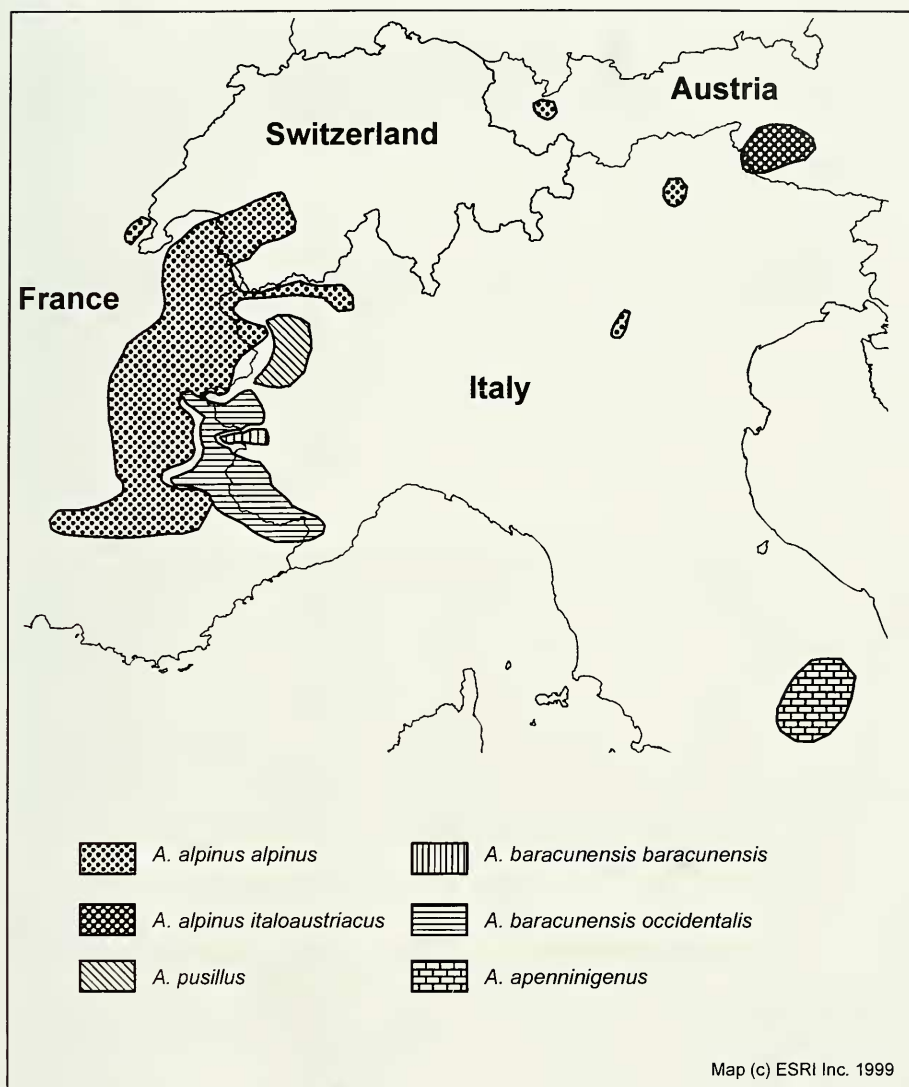


FIG. 17

Distribution areas of *Anonconotus* species and subspecies, according to the present revision.

♀: with the exception of *A. alpinus*, which has much larger EL, other species are very similar and isolated specimens are impossible to identify with certainty. Populations with more than 50 % of ♀ with continuous DOLI undoubtedly belong to *A. pusillus* sp. n.

Description of the holotype

Size: PF 9.6; PR 4.4. EL hidden under the PR. PR reddish-brown on disc, lighter on metazona; paranota black, margin broadly bordered with light mint-green anteriorly, with greenish white ventrally and posteriorly. TIT: all brown, apical parts with 4 and 5 teeth, respectively.

Variation

Size: ♂ (n = 66): PF 9.1-12.2; PR 4.1-5.2; ♀ (n = 43): PF 12.2-14.8; PR 4.7-5.7). Important intraspecific variation of PF/PR lengths within and between localities. Partially overlapping with *A. baracunensis* in PF and PR lengths but tending to have smaller values (Fig. 3). Stature of ♂ distinctly slender (Fig. 2), body short and narrow, abdomen parallel-sided as seen from above; adult ♂ very resembling a subadult of another species of *Anonconotus* ! General stature of ♀ similar with that of *A. baracunensis*. Sexual dimorphism striking, much more pronounced than in other species.

PR shape: similar to that of *A. baracunensis*, although smaller on average (Fig. 3, 4a, 5a).

EL: ♂ (Fig. 4a, 6a): reaching 3/4 of META to 1/4 of T1; smallest EL of all *Anonconotus*. EL light or deep yellow, often more translucent than in *A. baracunensis* because of weakest venation. ♀ (Fig. 5a): EL reaching 1/5 to 1/2 of the META, generally protruding but sometimes completely hidden under the PR; whitish, yellowish or grey. EL usually more visible than in *A. baracunensis* because of slightly smaller pronotum (averages: 5.2 vs. 5.4, n = 43 and 21 respectively).

TIT: variation in shape and size given in Fig. 15-16; apical part generally brown, short, conical, more or less elongated, teeth medium-sized; basal part always brown or light brown, not flattened but thick, more half-cylindrical, generally slightly widened basally, prolonging the apical part without any angle, then bent and regularly curved ventrally, never twisted.

Body color and pattern: ♂: overall very shining (Fig. 2e-g); background color green, more or less black laterally on abdomen (melanism), pleura and paranota; DOBA a warm, slightly reddish brown (Fig. 2e-f), sometimes a cold greenish brown (Fig. 2g), rarely mottled olive green/brown; DOLI light buffish-white, continuous along the abdominal tergites T1-T9, very striking when bordered externally with black; PR: prozona greenish or brown, metazona generally brown; margin of paranota largely light green or mint-green anteriorly, whitish ventrally and extending posteriorly as a fine, bright mint-green line. Very typical "tricolor-striped" (brown/buff/black) appearance. ♀ very variable, green or olive to light brown with buffish tinge, also mottled with brown and green; DOLI buff whitish continuous in about 99 % of ind. (Fig. 2h). PF (♂, ♀) a honey-like color, light yellowish-brown, generally with a yellowish streak inferiorly.

Song

Unknown.

Distribution

Italy, endemic to the Grées Alps, in the sector delimited by the Aosta Valley and the Susa Valley, at the eastern margin of the Gran Paradiso Massif.

DISTRIBUTION

All checked data are given in the Appendix. Fig. 17 shows the distribution ranges of all species. They are allopatric-(parapatric) with rare, very small areas of sympatry. *A. alpinus* and *A. baracunensis occidentalis* occur at the same site but not in the same habitat and altitude at two localities. Nadig (1987) reports the case of the south-exposed slopes north of the Col de Montgenèvre (France near the Italian border, Hautes-Alpes): *alpinus* from 1850 m a.s.l. to about 1930 m, *b. occidentalis* from 1930 m upwards. Harz (1969) reports a similar situation from the Col de la Bonette (France, Alpes Maritimes / Alpes de Haute-Provence border: *A. alpinus* at 1200 m, *A. b. occidentalis* at 2000 m. *A. alpinus* and *A. pusillus* occupy the western and eastern parts of the Gran Paradiso Massif (North-Western Italian Alps), respectively; we did not find any zone of sympatry, but they occur very close to each other in Val dell'Orco (Val Locana). The Susa Valley separates *A. pusillus* (north) and *A. b. occidentalis* (south). The two ssp. of *A. baracunensis* have never been found together on the same mountain (Nadig, 1987).

DISCUSSION

We agree with Dreux (1962) and Nadig (1987) that the structure of the prosternum and the number of spines on the fore tibiae are very variable and cannot be considered as reliable characters. The size of the ♂♂ cerci varies interspecifically proportionally with the body size but this character is difficult to use to separate species; furthermore, we found that their shape, the presence or absence of an apico-external tooth and the shape of the apico-internal tooth are more variable characters than previously considered (by Nadig, 1987, for instance). The shape of the titillators is an important taxonomic character. Nevertheless, the titillators show a considerable intraspecific variability, and in the case of closely related species (as in our *Anonconotus*), their intraspecific variability sometimes obliterates interspecific variability. In some rare cases, we were confronted with *Anonconotus* specimens which could not be identified with certainty using only this character. Finally, the song is an important taxonomic character. However, the squamipterous ♂♂ of *Anonconotus* seem to have a reduced song activity and their song is difficult to record. So far, only the song of *A. alpinus* has been recorded and described (Heller, 1988; Ragge & Reynolds, 1998). Some observations of singing specimens of different populations indicated that this character could also be of taxonomical value for the *Anonconotus* species but more research is needed. As a general rule, we recommend the collection of males, which possess most of the diagnostic characters for identification of species, and the use of a combination of several characters rather than only one.

Anonconotus ghiliani Camerano, 1878 was first considered as a variety of *Anonconotus alpinus* (Yersin, 1858) by Chopard, 1952, then by following authors (Harz, 1969; Nadig, 1987). It is still considered as a distinct species by Otte (1997). This "species" has been described by Camerano (1878) on the basis of only one pair of specimens caught in Oropa near Biella (Italy). We studied topotypical material of *A. ghiliani* and the redescription of this "species" given by Griffini (1892) and came to the same conclusion as Nadig's (1987): this entity is only a dark-colored variety of *A. alpinus alpinus*.

Taxonomic studies on allopatric populations often need a concept other than the biological species concept. One could collect specimens from different mountains and undertake laboratory experiments to study mate choice, interbreeding and fertility of offspring, but artificial conditions cause artifacts and the specimens may be interfertile in the laboratory but not under natural conditions. Interfertility is not a definitive criterion in the phylogenetic and evolutionary concepts of species.

The ranking (species / subspecies) of allopatric populations depends on the species concept that one considers. In the Western Alps, the distribution areas of the *Anonconotus* species and subspecies have boundaries separated by only a few kilometers and overlap sometimes, but so far no hybridization has been observed. Although intraspecific variability in some characters can be rather high, due to isolation of populations during the Holocene or the last glacial period, the taxa examined retain their diagnostic characteristics all over their distribution area. As we do not have intermediate populations with intergrading character states, the described taxa may all be good species. Nevertheless, we defined species and subspecies in the present work. We did so by comparing the amount of morphological difference between the taxa, i.e. the number of taxonomically important characters. All characters were given the same weight. We think that allopatric taxa distinguished by only one versus several characters should not be given the same taxonomic rank. Consequently, we treated the Gran Paradiso populations, which accumulate several characteristics, as a distinct species (*A. pusillus* sp. n.). On the other hand, the former Alpine "*A. apenninigenus*" and *A. baracunensis* sensu Nadig, 1987 differ only by a single character and were treated as ssp. of a single polytypic species.

Within the family Tettigoniidae, the shape of the titillators allows for the identification of externally very similar taxa but in our opinion this single character does not, by itself, give any information on the taxonomic rank. Two distinct species may have similar titillators, and different populations of a single species may show very different ones (as in *Ephippiger ephippiger* Fiebig, 1784, Ephippigerinae). Considering the taxonomic characters generally used in our group, the european Platycleidini (Tettigoniinae), it seems that no case exists where a difference in the titillators is the only character for separating two species. There is no case where the gene flow between two sympatric and syntopic sibling species is interrupted by a single difference in titillators. Regarding allopatric taxa, the numerous allopatric species of *Parnassiana* Zeuner, 1941 of the Greek mountains differ at least in one other character besides the titillators (Harz, 1969; Willemse, 1985). Titillators seem to be the only reliable character to distinguish some Mediterranean *Eupholidoptera* Ramme, 1951 species (see Willemse, 1984, 1985 for examples), but these are all allopatric taxa with very limited distribution areas (a single mountain or a single small island) and the taxonomic status of these allopatric taxa may be questionable.

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APPENDIX. Checked distributional data for *Anonconotus* spp. based on re-identified material (some *A. a. italoaustriacus* and a few literature data have not been checked). All geographic names are given in the local language. Localities are geographically ordered, from the Southern to the Northern and Eastern Alps.

Obs. = observer or/and collector; year = year of collection; cou. = country; A = Austria, CH = Switzerland, F = France, I = Italy; col. = examined collection (1 = Harz, 2 = Nadig, 3 = Carron, 4 = La Greca); alt. = altitude in meters above sea-level.

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
<i>alpinus alpinus</i>								
Walther	1965	F	1	Vaucluse	Mont Ventoux	Mont Ventoux		
Nadig	1975	F	2	Vaucluse	Mont Ventoux	Mont Ventoux	1450- 1650	Nadig, 1987
Nadig	1977	F	2	Vaucluse	Mont Ventoux	Mont Ventoux	1000- 1400	Nadig, 1987
Carron & Wermeille	1997	F	3	Vaucluse	Mont Ventoux	Mont Ventoux		
Eckerlein	1956	F	1	Alpes de Haute- Provence	Sisteron (south of)	Montagne de Luge (sic) = Lure		
Nadig	1975	F	2	Alpes de Haute- Provence	Seyne (south of)	Col de Maure	1346	Nadig, 1987
Nadig	1975	F	2	Alpes de Haute- Provence	Seyne	Col du Fanget	1600	Nadig, 1987
Nadig	1975	F	2	Alpes de Haute- Provence	Seyne	Tête grosse	1700- 1750	Nadig, 1987
Nadig	1975	F	2	Alpes de Haute- Provence	Col de la Cayolle	Col de la Cayolle, S- side	2000- 2100	Nadig, 1987
Carron & Sardet	2001	F	3	Alpes de Haute- Provence	Allos	Col d'Allos	2270	
Heller	1984	F		Alpes de Haute- Provence	Jausiers (Hte vallée de l'Ubaye)	Col de la Bonette		Heller, 1988
		F		Alpes de Haute- Provence	Jausiers (Hte vallée de l'Ubaye)	Col de la Bonette	1200	Harz, 1969
Nadig	1975	F	2	Drôme, Ouvèze springs	Buis les Baronnies	Col de Perty	1100- 1300	Nadig, 1987
Nadig	1991	F	2	Hautes-Alpes	Montgenèvre (Briançon)	Col de Montgenèvre, E Bois des Suffins	1900- 2110	
Nadig	1984	F	2	Hautes-Alpes	Montgenèvre (Briançon)	Col de Montgenèvre	1850- 1930	Nadig, 1987
Meduri	1966	I	4	Piemonte (Val di Susa)	south of Bardonecchia, near Melezet	Punta Colomion	1600	
Meduri		I	4	Piemonte (Val di Susa)	Bardonecchia	Bardonecchia	1300	
Meduri	1966	I	4	Piemonte (Val di Susa)	Bardonecchia	Monte Jafferau	2000	
Carron & Sardet	2000	I		Piemonte (Val di Susa)	Oulx (Savoulx)	under rochers de l'aigle (near M. Jafferau)	2350	
Meduri		F	4	Hautes-Alpes	Chapelle St Hippolyte	Vallée étroite (Briançon)	1790	
Carron & Sardet	2001	F		Hautes-Alpes	Col du Lautaret	Col du Lautaret	2100	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
Carron & Sardet	2001	F		Hautes-Alpes	Col du Lautaret - Col du Galibier, road between	Col du Lautaret - Col du Galibier, road between	2340	
Carron & Sardet	2001	F	3	Hautes-Alpes	Col du Galibier, S-side	Col du Galibier, S-side	2555	
Carron & Sardet	2001	F		Hautes-Alpes / Savoie	Col du Galibier	Col du Galibier	2770	
Sardet	1999	F		Savoie, Maurienne	Valmorel (near Moutiers)	Col du Gollet	1970	
Coin	1991	F		Savoie, Maurienne	Modane, Valfréjus (Maurienne, N Fréjus)	lacs de Sainte-Marguerite (Mt Thabor)	2400	Bellmann & Luquet, 1995
Nadig	1984	F	2	Savoie	Val d'Isère	Col d'Iséran, N-side	2180-2320	Nadig, 1987
Sardet		F		Savoie	Val d'Isère	Col d'Iséran	2320	
Sardet	2000	F		Savoie	Val d'Isère	Tête d'Arolla	2533	
Sardet	1997	F		Savoie	Tignes	Croix du Bano	1980	
Sardet	2000	F		Savoie	Tignes	Grande Sassière, Plan du cheval	2500	
Nadig	1984	F	2	Savoie	Bourg St-Maurice	Col du Petit St Bernard, S-side	2070-2100	Nadig, 1987
Carron & Sardet	2001	F		Haute-Savoie	Mieussy	Pointe de Chavasse	1500-2000	
Nadig	1990	I	2	Val d'Aoste	V. Veni (west of Courmayeur)	V. Veni (west of Courmayeur)	1960-2000	
Nadig	1990	I	2	Val d'Aoste	La Thuile, Courmayeur	Chadura above La Thuile	2200	
Nadig	1990	I	2	Val d'Aoste	La Thuile, Courmayeur	La Thuile main road	1960	
Nadig	1991	I	2	Val d'Aoste	La Thuile, Courmayeur	under the Col	2100	
Nadig	1990	I	2	Val d'Aoste	La Thuile, Courmayeur	M. Belvedera	2400-2640	
La Greca	1967	I	4	Val d'Aoste	La Thuile, Courmayeur	Col du Petit St Bernard	1950-2150	
La Greca	1967	I	4	Val d'Aoste	La Thuile, Courmayeur	Les Suches (= La Souche, la Thuile?)	2200	
Goidanich	1952	I	4	Piemonte (Val dell'Orco)	Ceresole reale	Ceresole (haut val dell'Orco)	1700	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
Goidanich	1953	I	4	Piemonte (Val dell'Orco)	Ceresole reale	la Merola (above Ceresole)	2000	
La Greca	1967	I	4	Val d'Aoste (Valtoumenche)	Chamois	Chamois	2000	
Nadig	1990	I	2	Val d'Aoste (Valle d'Ayas - Verrès)	Champoluc	Ostafa above Champoluc	2100- 2350	
Carron & Praz	1999	I	3	Val d'Aoste (Val di Gressoney)	Gressoney	Gressoney-la-Trinité		
Nadig	1985	I	2	Val d'Aoste (Val di Gressoney)	Gressoney	Bettaforca	1950- 2350	Nadig, 1987
La Greca	1967	I	4	Val d'Aoste (Val di Gressoney)	Gressoney	Mont Gabiet (Gressoney-la- Trinité)	2300	
Nadig	1917	I	2	Piemonte (Val Sesia)	Alagna- Valsesia	Alagna	2000- 2300	Nadig, 1987
Nadig		I		Piemonte (Val Sesia)	Biella	Oropa		Nadig, 1987
Ghiliani		I		Piemonte (Val Sesia)	Biella	Monti Biellisi		Fruhstorfer, 1921
Frey- Gessner		F		Ain	Thoiry	Recullet		Fruhstorfer, 1921
Carron & Sardet	2001	F	3	Ain	Thoiry	Recullet	1700	
Carron	1994 ?	CH		Ct. Valais	Vouvry	Miex-Col de Verne	1500- 1600	
Praz	1997	CH	3	Ct. Valais	Champéry	Col de Bretolet	2000	
Fruhstorfer		CH		Ct. Vaud	Montreux / Veytaux	Dent de Jaman		Fruhstorfer, 1921
Nadig	1922	CH	2	Ct. Vaud	Montreux / Veytaux	Rochers de Naye		Nadig, 1987
Frey- Gessner		CH		Ct. Vaud	Montreux / Veytaux	Rochers de Naye		Fruhstorfer, 1921
Nadig	1978	CH	2	Ct. Vaud	Lavey-Morcles	Le Crêtelet - La Tourche	1950- 2250	Nadig, 1987
Yersin, Meyer-Dür		CH		Ct. Vaud / Valais	Lavey-Morcles / Fully	Dent de Morcles	2000	Fruhstorfer, 1921
Carron	1999	CH		Ct. Valais	Dorénaz	Lui - Scix Carro	2100- 2300	
Carron	2001	CH	3	Ct. Valais	Dorénaz	Lui - Scix Carro	2100- 2300	
Gams	1919	CH		Ct. Valais	Dorénaz	Pacoteires above Alesses	2100	Fruhstorfer, 1921
Carron	1999	CH		Ct. Valais	Fully	Lui, Portail de Fully	2200- 2300	
Carron	2001	CH		Ct. Valais	Fully	Lui, Portail de Fully	2200- 2300	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
Fruhstorfer		CH		Ct. Valais	Fully	Grand Château (above Fully)	2000	Fruhstorfer, 1921
Fruhstorfer		CH		Ct. Valais	Fully	Grand Chavalard	2000- 2500	Fruhstorfer, 1921
Nadig	1982	CH	2	Ct. Valais	Leytron	Ovronnaz, Châtillon	1820- 1980	Nadig, 1987
Carron	1995	CH		Ct. Valais	Conthey	Col du Sanetsch	2280	
Carron	1999	CH		Ct. Valais	Conthey	Col du Sanetsch	2280	
Carron	1999	CH	3	Ct. Valais	Conthey	Col du Sanetsch	2280.0	
Baur (B & H)	1988	CH		Ct. Berne, Niedersimmental	Boltigen	Vordere Reidigen	1420	
Baur (H)	1988	CH		Ct. Berne, Niedersimmental	Boltigen	Chlusalp above Reidenbach	1200	
Roesti		CH		Ct. Berne, Engstligental	Adelboden			
		A		N-Tirol (Arlberg)	St. Anton			Harz, 1969
	1988	A		N-Tirol (Arlberg)	St. Anton			Luquet, 1995
Krauss / Nadig	Nadig 1985	A	2	N-Tirol (Arlberg)	St. Anton	Ulmerhaus	2280	Krauss, 1909; Nadig, 1987
Krauss / Nadig	Nadig 1985	A	2	N-Tirol (Arlberg)	St. Anton	Ob. Steissbachtal	2000- 2200	Krauss, 1909; Nadig, 1987
Nadig	1985	A	2	N-Tirol (Arlberg)	St. Anton	near Gampen	1800	Nadig, 1987
Krauss	1909	I		Veneto, S-Tirol	Schlem	Schlem	2200	Krauss, 1909
Ramme	1921	I		Veneto, S-Tirol	Schlem	Schlem	2200	in Nadig, 1987
Nadig	1987	A	2	Kärnten Reiseckgr.	Kaponiktal	Kaponiktal	1800- 2000	
<i>alpinus ssp. ?</i>								
Krauss	1900	I		Veneto, Monte Baldo	Monte Baldo	Altissimo di Nago	2076	Krauss, 1909
<i>alpinus italoaustriacus (all from Nadig, 1987)</i>								
Werner	1929	A		E-Tirol, Schober- Gruppe	Zetttersfeld	above Biedner-Hütte	2000- 2200	Werner, 1929, 1931, 1934
Werner	1930	A		E-Tirol, S-Seite der Hohen Tauern	Kaiser Törl	Kaiser Törl	2000	Werner, 1931

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
Franz	1940	A		Kärnten, Sonnblickgruppe	Gr. Fleiss		1900	in Nadig, 1987
Nadig	1986	I	2	S-Tirol, Sexten-Tal	Hahnspielhü.- Helm	Hahnspielhü.-Helm	2050- 2350	
Nadig	1982	I	2	Veneto, S-Tirol, Pustertal, Defereggen-Gebirge	Strickberg	above Innichen	2050- 2150	Nadig, 1987
<i>probably alpinus italoaustriacus (all from Nadig, 1987)</i>								
Werner	1930	A		E-Tirol	Ederplan (Lienz)	under Annahütte and Gipfelplateau	1950	Werner, 1931, 1934
Hölzel	1943	A		Sandnig-Sonnblick- Gruppe				Hölzel, 1955
<i>apenninigenus</i>								
La Greca	1966	I	4	Lazio, Monti Reatini	Monte Terminillo	Jaccio Crudele	1900	
Baccetti	1966	I		Lazio, Monti Reatini	Monte Terminillo	Jaccio Crudele	1900	Baccetti, 1971
Baccetti	1966	I		Lazio, Monti Reatini	M. Porcini	M. Porcini	1900	Baccetti, 1971
Baccetti	1967	I		Lazio, Monti Reatini	Colle delle Pozze	Colle delle Pozze	1900	Baccetti, 1971
Baccetti	1967	I		Lazio, Monti Reatini	M. di Cambio	M. di Cambio	1900	Baccetti, 1971
Galvagni / Nadig	1979	I	2	Marche, Monti Sibillini	val Bolognola	Fonte Bassette	1500- 1700	Nadig, 1987
Carron & Wermeille	2001	I	3	Marche, Monti Sibillini	val Bolognola	Monte Rotondo, val Bolognola		
Galvagni	1954	I		Marche, Monti Sibillini	Monti Sibillini	path from Forca Viola to Lago Pilato Monti, Monti Sibillini	1900	Galvagni, 1959
<i>baracunensis baracunensis</i>								
Carron & Sardet	2000	F	3	Hautes-Alpes	Ristolas	Belvédère du Viso- Le Sellard, Sommet de l'Olive	1900- 2550	
Nadig	1991	F	2	Hautes-Alpes	Ristolas	Monviso N-side, Petit Belvédère du Viso (Torrent du Pisset)	1775	Carron & Sardet, 2001
Nadig	1991	F	2	Hautes-Alpes	Ristolas	Monviso N-face, above Belvédère du Cirque	2130- 2380	Carron & Sardet, 2001
Carron & Praz	1998	I	3	Piemonte (Alto Valle del Po)	Crissolo	Pian del Ré, Pô springs	2200- 2400	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
La Greca	1967	I	4	Piemonte (Alto Valle del Po)	Crissolo	Pian Melzé (between Crissolo et Pian del Ré)	1750	
Nadig	1991	I	2	Piemonte (Alto Valle del Po)	Crissolo	above Pian del Re	2150- 2500	
La Greca	1967	I	4	Piemonte (Alto Valle del Po)	Crissolo	Rocce Losere	2050	
Heller	1987	I		Piemonte (val Pellice)	Bobbio Pellice	Rif. Barbara, 8 km S of B. Pellice		Heller, 1988
Nadig	1985	I	2	Piemonte (Valle Pellice)	Bobbio Pellice, Val Carboneri	under Cle Baracun, above Rifugio Barbara	2020	Nadig, 1987
Nadig	1991	I	2	Piemonte (Valle Pellice)	Bobbio Pellice, Val Carboneri	Cle Baracun	1900- 2000	
Nadig	1991	I	2	Piemonte (Valle Pellice)	Bobbio Pellice, Val Carboneri	Cle Baracun	2000- 2150	
<i>baracunensis occidentalis</i>								
Nadig	1986	I	2	Liguria	Monte Saccarello	M. Saccarello- Redentore, E-side	1900- 2150	
Nadig	1986	F	2	Alpes Mantimes	Monte Saccarello	M. Saccarello, W.- side	1730	
Nadig	1985	I	2	Piemonte (Cuneo)	Ormea	cle Termini	2000	
Nadig	1985	I	2	Piemonte (Cuneo)	Monesi	Colla Rossa E-side (Monesi) (= Monte Saccarello)	1830	Nadig, 1987
Harz		F / I		Alpes mantimes / Piemonte	Mont Bertrand	Mont Bertrand	1800	Harz, 1969
Nadig	1985	I	2	Piemonte (Cuneo)	C. del Becco N- side	C. del Becco N-side	2160	Nadig, 1987
Nadig	1985	I	2	Piemonte (Cuneo)	Vecchie (Col de la Celle	Colle Vecchie - Rifugio Barbera	2090- 2130	Nadig, 1987
Nadig	1985	F / I	2	Alpes mantimes / Piemonte	Col di Boana, S-side	C. di Boana S-side	2160	
Ferraris	1957	F / I		Alpes mantimes / Piemonte	Col de Tende	Col de Tende		Galvagni, 1959
Lombardo	1981	I	4	Piemonte (Valle Stura)	Valdieri	Termi di Valdieri	1700	
Nadig	1986	F	2	Alpes Mantimes	St Martin Vésubie	M. Fenestre	1900- 2050	
Lombardo	1981	F	4	Alpes-Mantimes	St Martin Vésubie	Madonne de Fenêtre	2000	
La Greca	1967	I	4	Piemonte (Valle Stura)	Demonte	Passo Gardetta	2330	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
La Greca	1967	I	4	Piemonte (Valle Stura)	Demonte	Valle dell'Arma	2000-2200	
Nadig	1978	I	2	Piemonte (Valle Stura)	Demonte	Valle dell'Arma, towards Colle del Mulo	1300-1600	Nadig, 1987
Nadig	1976	F	2	Alpes Maritimes Piemonte (Valle Stura)	Col de la Lombarde, S-side	Col de la Lombarde, S-side	2050-2250	Nadig, 1987
La Greca	1967	I	4	Piemonte (Valle Stura)	Vinadio	vallone S. Anna	1700	
Nadig	1978	I	2	Piemonte (Cuneo)	Frabosa	Prato Nevoso, under Rif. Balma	1780	Nadig, 1987
Nadig	1986	F	2	Alpes Maritimes	Mercantour	V.d. Casterne	1750	
Nadig	1986	F	2	Alpes Maritimes	Mercantour	Fontanaibes	2000-2200	
La Greca	1981	F / I	4	Piemonte / Alpes de Haute-Provence	Argentera	Colle Maddalena = Col de Larche	2000	
Nadig	1975	F / I	2	Piemonte / Alpes de Haute-Provence	Argentera	Colle Maddalena = Col de Larche	1850-2000	Nadig, 1987
Walther	1966	F	1	Alpes de Haute-Provence	Jausiers (Hte vallée de l'Ubaye)	Col de la Bonette	2000	Harz, 1969
Nadig	1975	F	2	Alpes de Haute-Provence / Hautes-Alpes	Jausiers (Hte vallée de l'Ubaye)	Col de Vars	1700-2100	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Grana)	Val Grana	Monte Reina, S-Hang	1960	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Grana/Val Maira)	Marmora	Colle d'Esischie-Cle. Mulo	2100-2500	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Maira)	Val Maira	Elva	1600	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Maira)	Val Maira	Col de Sampeyre, S-side	2280-2300	Nadig, 1987
La Greca	1967	I	4	Piemonte (Val Varaita)	Sampeyre	Col de Sampeyre	2300	
Carron & Praz	1998	I	3	Piemonte (Val Varaita)	Sampeyre	Col de Sampeyre		
Nadig	1985	I	2	Piemonte (Val Varaita)	Sampeyre	Col de Sampeyre, N-side	1900	Nadig, 1987
Carron & Praz	1998	I	3	Piemonte (Val Varaita)	Casteldelfino (Sampeyre)	Chiazale, val Varaita di Rui, Monte Mongioia	2600	
La Greca	1967	I	4	Piemonte (Val Varaita)	Casteldelfino (Sampeyre)	Chiazale	2000	
La Greca	1967	I	4	Piemonte (Val Varaita)	Pontechianale	Le Conce (Monte-)	2400	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
La Greca	1967	I	4	Piemonte (Val Varaita)	Pontechianale	Chianale	1800	
Nadig	1985	I	2	Piemonte (Val Varaita)	Pontechianale	Cle del Agnello, SE- side (near Chianale)	2180	Nadig, 1987
Nadig	1991	I	2	Piemonte (Val Varaita)	Pontechianale	Cle del Agnello, SE- side (near Chianale)	2100	
Nadig	1985	I	2	Piemonte (Val Varaita)	Pontechianale	Cle del Agnello	2700- 2900	Nadig, 1987
Nadig	1991	F	2	Hautes-Alpes (Queyras)	St Véran	Cle del Agnello, NW side	2100- 2500	
Nadig	1991	F	2	Hautes-Alpes (Queyras)	Château Queyras	Sommet Bucher	2200- 2250	Carron & Sardet, 2001
Nadig	1975	F	2	Hautes-Alpes	Col d'Izoard	Col d'Izoard	2300- 2456	Nadig, 1987
Nadig	1991	F	2	Hautes-Alpes	Col d'Izoard	Col d'Izoard	2300- 2420	
Carron & Sardet	2000	F		Hautes-Alpes	Col d'Izoard	Col d'Izoard	2400	
Carron & Sardet	2000	F	3	Hautes-Alpes	Col d'Izoard, N- side	Refuge Napoléon	2300	
La Greca	1967	I	4	Piemonte (Val Germanasca)	Ghigo	Cappello d'Envie (Punta Cialancia)	2550	
Nadig	1985	I	2	Piemonte (Val Germanasca)	Ghigo	Tredici laghi - Punta Cialancia	2250- 2750	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Germanasca)	Ghigo	above Ghigo	1740- 1800	Nadig, 1987
La Greca	1967	I	4	Piemonte (Val Germanasca)	Perrero	Ribba, Pinerolo (?)	1700	
Nadig	1985	I	2	Piemonte (Val Germanasca)	Perrero	Conca Cialanca (= Punta Cialancia)	2260	Nadig, 1987
Nadig	1985	I	2	Piemonte (Val Germanasca)	Perrero	road to Co. Cialancia	1600	Nadig, 1987
Heller	1987	I		Piemonte (Val Germanasca)	Perrero	Conca Cialanca (= Punta Cialancia)		Heller, 1988
La Greca	1967	I	4	Piemonte (Val Chisone)	Cumiana	Monte Uia, Cumiana, Pinerolo	2100	
La Greca	1967	I	4	Piemonte (Val Chisone)	Fenestrelle	Rif. Sellenes	2020	
Nadig	1975	I	2	Piemonte (Val Chisone)	Fenestrelle	Cle Finestre	2100- 2200	Nadig, 1987
Carron & Praz	1998	I		Piemonte (Val Chisone)	Fenestrelle	Col Blegier		
Nadig	1975	I	2	Piemonte (Val Chisone)	Fenestrelle	Col Blegier	2400- 2550	Nadig, 1987
Carron & Praz	1998	I	3	Piemonte (Val Chisone)	Pragelato	Col de l'Assietta		

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
La Greca	1967	I	4	Piemonte (Val Chisone)	Pragelato	Col de l'Assietta	2470	
Nadig	1975	I	2	Piemonte (Val Chisone)	Pragelato	Col de l'Assietta	2300- 2550	Nadig, 1987
La Greca	1967	I	4	Piemonte (Val Chisone)	Sestrière	Colle Basset	2200- 2400	
La Greca	1967	I	4	Piemonte (Val Chisone)	Sestrière	M. Sises	2700	
Nadig	1975	I	2	Piemonte (Val Chisone)	Sestrière	Sestrière	2300- 2550	Nadig, 1987
Carron & Praz	1998	I		Piemonte (Val Chisone)	Sestrière	Colle Basset	2420	
La Greca	1967	I	4	Piemonte (Val di Susa)	Torinese (Oulx)	Colle Bercia (Cesana Torinese)	2250	
La Greca	1967	I	4	Piemonte (Val di Susa)	Torinese (Oulx)	Colle Bercia (Cesana Torinese)	1700	
Nadig	1991	I	2	Piemonte (Val di Susa)	Cesana Torinese (Oulx)	Monti della luna, C. Bercia, above Sagna Lunga	2260	
Nadig	1991	I	2	Piemonte (Val di Susa)	Clavière (Col Montgenèvre)	Pian Gimont	2080	
Nadig	1984	F	2	Hautes-Alpes	Montgenèvre (Briançon)	Col de Montgenèvre	1930	Nadig, 1987
Carron & Sardet	2000	F	3	Hautes-Alpes	Montgenèvre (Briançon)	north-exposed slopes	1850- 2000	
Nadig	1984	F	2	Hautes-Alpes	Montgenèvre (Briançon)	Durance springs - Plateau Gondran	2070- 2300	Nadig, 1987
<i>pusillus</i>								
Carron & Sardet	2000	I	3	Piemonte	Col Colombardo	Col de Colombardo, N-side	1410 (?)	
Nadig	1985	I	2	Piemonte	Col Colombardo	Col de Colombardo	1850- 1900	Nadig, 1987
Nadig	1985	I	2	Piemonte	Col Colombardo	Col de Colombardo N-side	1660	Nadig, 1987
Goidanich	1953	I	4	Piemonte (Val dell'Orco)	Locana	val dell'Orco Teleccio	2400	
Goidanich	1953	I	4	Piemonte (Val dell'Orco)	Locana	val dell'Orco Teleccio	2400	
Carron & Sardet	2000	I	3	Piemonte (Val Soana)	Valprato Soana	Piamprato	1800- 1900	
Nadig	1985	I	2	Piemonte (Val Soana)	Valprato Soana	Piamprato (SW-side)	1750- 1900	Nadig, 1987
Goidanich	1953	I	4	Piemonte (Val Soana)		S. Bessa, S. Besso	2200	
Goidanich	1953	I	4	Piemonte (Val Soana, Val di Forzo)	Ronco canavese	Forzo	2200	

obs.	year	cou.	col.	region (A, I), canton (CH), department (F)	locality	site	alt.	reference if published
Carron & Sardet	2000	I	3	Piemonte (Canavese)	Santa Elisabetta	Santa Elisabetta	1400- 1500	
Nadig	1985	I	2	Piemonte (Canavese)	Santa Elisabetta	Santa Elisabetta	1400- 1500	Nadig, 1987
Nadig	1991	I	2	Piemonte (Canavese)		M. Soglio S-side to the top	1800- 2000	
Nadig	1990	I	2	Val d'Aoste (Val Champorcher)	Champorcher	Dondenaz	2100- 2200	
Carron & Praz	1999	I	3	Val d'Aoste (Val Champorcher)	Chardonney	Laris	2000- 2300	
Carron & Sardet	1999	I		Val d'Aoste (Val de Cogne)	Cogne-Lillaz	Loye	(2100- 2300)	
Carron & Manco	1999	I		Val d'Aoste (Val de Cogne)	Cogne-Lillaz	Loye	2216	
Goidanich	1955	I	4	Val d'aoste (Val Savaranche)	Orville	Orville	2200	

Appendix, 10